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32

Information and communication technologies for disaster risk management in the Caribbean

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UNITED NATIONS

ECLAC

This document was prepared under the supervision of Peter Nicholls, Chief Caribbean Knowledge Management Centre (CKMC) at the ECLAC Subregional Headquarters for the Caribbean. The initial draft was written by Atiba Philips, a Consultant, and was revised by Robert Crane Williams, Associate Information Management Officer at CKMC.

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United Nations publication
ISSN 1727-9917
LC/L.3759
LC/CAR/L.430
ORIGINAL: ENGLISH

Printed at United Nations, Santiago, Chile

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Abstract

This paper examines the role of information and communications technologies (ICTs) for disaster risk management (DRM) with a specific focus on the Caribbean. The study included the review of literature and case studies, as well the administration of a survey instrument that collected the feedback of 13 regional national DRM agencies.

Analysis of the survey suggests that while subregional disaster management agencies have fairly good access to technology infrastructure and enjoy an information sharing culture, challenges exist with regard to the information governance frameworks as well as the capacity and availability of human capital with regard to ICT. The study findings indicate that the regional DRM sector would do well to:

- Deepen connections with policy makers and other communities of practice
- Modernize ICT Infrastructure for DRM
- Consider a subregional e-strategy for DRM
- Improve ICT governance
- Urgently develop programmes of ICT human capacity development.

I. Introduction

When disasters have hit the Caribbean, they have been devastating – killing people, destroying economies, and reversing hard-earned development gains. Hurricane Ike, in 2008, is estimated to have caused over US$7 billion worth of damage in Cuba alone, and the 2010 earthquake in Haiti killed well over 100,000 people – a number compounded by inadequate building codes, poor land use decisions, and tough living conditions.

The small economies of the region do not have the resilience to easily absorb the shock caused by natural disasters. The Eastern Caribbean Central Bank reports that in 1995, because of Hurricane Luis, Antigua and Barbuda saw losses of 4,000 to 7,000 jobs, representing an estimated 15-25% of the workforce. Anguilla too was hit by Hurricane Luis, and saw real output decline by 4.2%. The damage caused to St. Kitts and Nevis by Hurricane Georges in 1998 represented a value of almost twice the nation's annual GDP (Douglas, 2009). The reduction in growth and cost of reconstruction from disasters like these has contributed to the high burdens of national debt that many Caribbean countries continue to struggle with.

Disaster occurrences cannot be eliminated, but they can be better managed. The successful management of emergency situations requires proper planning, guided response, and well-coordinated efforts across the disaster management life cycle.

The professionals responsible for the coordination of disaster response face difficult challenges in times of disaster. Managing priorities, capacities, locations, and the expectations of governments and the public is a complex and dynamic endeavour. In addition, given the turbulent nature of disaster situations, the people and systems at disaster management offices are subjected to information overload, which can obstruct timely and accurate decision making.

Information and Communication Technologies (ICTs) can be used support the practice of disaster risk management (DRM) in times of crisis, as well as in times of planning and in times of reconstruction. The revolutionary potential of ICTs lies in their ability to instantaneously connect vast networks of individuals and organizations across great geographic distances, and to facilitate fast flows of information, capital, ideas, people and products. ICTs have become essential tools for cooperation and collaboration.

With ICTs – in particular computers, the Internet and mobile phones – the constraints on the place and time for interaction have eased considerably. This can play a catalytic role in disaster risk management.

ICTs are important tools for lessening disaster risks through:

- Detection and analysis of dangers
- Propagation of early warning messages to populations in harm's way
- Coordinating and tracking relief activities and resources
- Recording and dissemination of knowledge and experiences
- Raising awareness (UN-APCICT, 2010).

This study therefore seeks to expand understanding and appreciation of ways in which ICTs can be used for disaster risk reduction, and in turn, generate opportunities for networking, collaboration and implementation of new solutions that are both well-suited to the Caribbean and based on international experience and best practices.

Specifically, this study aims to determine the following:

- How are ICTs being used to facilitate and enhance the practice of disaster risk management (DRM) in the Caribbean?
- What are the current gaps and challenges?
- How can these gaps and challenges be addressed?

Departments and agencies responsible for ICT are also an important part of the audience for this study, so that they may be informed on ICT infrastructure and tools needed by Caribbean DRM practitioners. Engaging with all of those responsible for actions and decisions could enhance discussions, developments and implementation of ICT for disaster risk management.

As part of this study on ICT for disaster risk management in the Caribbean, the researches conducted a theoretical as well as an empirical study. The theoretical study consisted of a literature review of approximately 30 items, including relevant articles, research papers and case studies. The findings of this literature review are summarized in Chapters II and III, and they serve as the background to the empirical study, which consists of the analysis of a survey that is discussed in detail in Chapter IV. Chapter V concludes the study with recommendations and ways forward for the Caribbean.

The findings of the empirical study – and a preliminary draft of this document – were presented to a meeting of a group of experts in the fields of disaster risk management and ICT, and the findings of this group are incorporated into the text and conclusion of this study. Following the expert group meeting, a two-day training course was held with practitioners of ICT and DRM in the Caribbean and some elements of the discussion from this course are also incorporated into this study.

II. Elements of disaster risk management

Disaster risk management (DRM) is comprised of activities such as risk reduction, mitigation, prevention, preparedness, response and recovery. This encompasses the whole systematic and conceptual framework of closely linked measures that are taken before, during and after a disaster occurs.

The central aim of DRM is the reduction of the immediate and long-term impact on the people and communities exposed to the disaster risk. This generally involves reducing the vulnerability of the population itself to disaster events through awareness building, emergency planning as well as physical prevention and mitigation interventions. DRM also calls for taking measures toward the prevention of the occurrence of new secondary hazards related to human activity, such as landslides caused by inappropriate land use, or floods caused by deforestation (BMZ Federal Ministry for Economic Cooperation and Development, 2010).

In the practice of disaster risk management, there is a distinction between the concept of a hazard, and the concept of a disaster. A hurricane, for example, might be considered a hazard when it is out to sea; it is dangerous to those in its path, but would not be considered a disaster unless and until it was to have a widespread impact on land. One definition describes disaster as "an actual impact with consequences or losses that exceed the ability of an affected community or society to cope using its own resources" (ISDR, 2002).

Hazards and disasters may be considered natural or technological. Natural disasters include slow onset disasters, such as famine or drought, and sudden impact disasters such as volcanic eruptions, earthquakes, landslides and floods (Ngang and Kuo, 2010). Natural hazards can be grouped into three categories: hydro-meteorological, geological, biological.

The category of hydro-meteorological hazards includes all damage done by weather. The Caribbean is infamously at the mercy of tropical storms and hurricanes, although flooding and landslides represent hydro-meteorological events which most frequently impact the region. The category also includes drought, wild-land fires, temperature extremes and lightning damage.

Biological hazards include outbreaks of epidemic diseases, plant and or animal contagion and extensive infestations. The cholera epidemic in Haiti that followed the 2010 earthquake is an example of a biological hazard.

Geological hazards are common in the Caribbean region, which is home to its own tectonic plate, and to all the associated risks that come with it. Earthquakes are a relatively frequent occurrence in the region, and that danger has been magnified through the extensive construction of unreinforced masonry buildings. The Lesser Antilles are home to several active volcanoes, including the one on Montserrat, which last had a major eruption in 2010. The danger of tsunamis is also present.

Technological, or "man-made" hazards, include danger caused by technological or industrial accidents, infrastructure failures, or other human activities, and may include industrial pollution, dam failure, accidents, explosions, fires, spills, release of radioactive material, or damage caused by terrorism and warfare. The Deep Water Horizon oil spill that occurred in the Gulf of Mexico in 2010 is an example of a technological hazard.

A. Disaster vulnerability in the Caribbean context

Disasters are the result of hazards, of a population's vulnerability to those hazards, and of the state of resilience of the socio-economic infrastructure with regard to these extreme events. A hazard turns into a disaster when a severe disruption of the functioning of a system, be it natural or manmade, interacts with a community and results in widespread human, material, economic or environmental losses that exceed the ability of the affected community to cope using its own resources. A variety of social, cultural, economic, and environmental factors make up the complex dynamic of risk associated with the susceptibility of loss to these catastrophes (UNISDR, 2004a).

As discussed above, the Small Island Developing States (SIDS) of the Caribbean region are particularly vulnerable to a range of hazards, and these dangers are exacerbated by the relative isolation of these countries. Small island economies have limited resources with which to prepare for disaster, and their can have great difficulty in recovering from a setback. Damage caused by disasters has repeatedly had the effect of reversing hard-earned gains in development. Hurricane Gilbert, which hit Jamaica in 1988, for example, had an economic cost to the Jamaican economy of US$4 billion. Since that time, the pace of recovery of infrastructure and the economy has been slow (ECLAC 2013).

The limitations on financial and human resources mean that disaster risk reduction priorities must compete with other national development priorities, including the servicing of national debts. These debts are themselves exacerbated by the need to borrow money to cover post-disaster reconstruction costs. Of specific concern to this study, the small populations may lack the human resources capacity to develop and maintain sophisticated ICT systems for DRM.

Island countries must also contend with the constraints that geography and topology place on their infrastructure. In Barbados, for example, 90 per cent of the infrastructure is located close to the water, putting it at high risk for damage from a tropical storm or tsunami. Tourist infrastructure in particular, which is of great importance to many Caribbean economies, is generally located near the water. Thus, damage to tourism facilities as a result of a natural disaster can have a significant impact on the economy as a whole. Even before a disaster occurs, there can be a conflict between tourist infrastructure and measures required to mitigate the risks of coastal development, such as when a developer wishes to build a resort in a tsunami danger area.

BOX 1
UNPLANNED EXPLOSIONS AT MUNITIONS SITES: AN OVERLOOKED TECHNOLOGICAL HAZARD

In 1988, a wildfire near a military base in Chaguaramas, Trinidad and Tobago got too close to an ammunition storage facility. The munitions dump exploded, killing six and injuring 20. Since that time, the Caribbean has experienced other unplanned explosions at munitions sites (UEMS) in Guyana, Cuba, and the Dominican Republic. But damage caused by UEMS in the Caribbean has been comparatively light in comparison to other parts of the world. Since the Small Arms Survey started tracking UEMS in 1987, there have been over 453 reported incidents in 92 countries around the world.

A particularly tragic incident occurred on 4 March 2012, when 280 people were killed and over 1500 injured when a munitions dump exploded in a residential area in Brazzaville, Republic of Congo. The munitions dump had originally been located outside of the city, but as the city grew, development was allowed to occur in the surrounding area, resulting in a hazardous situation.

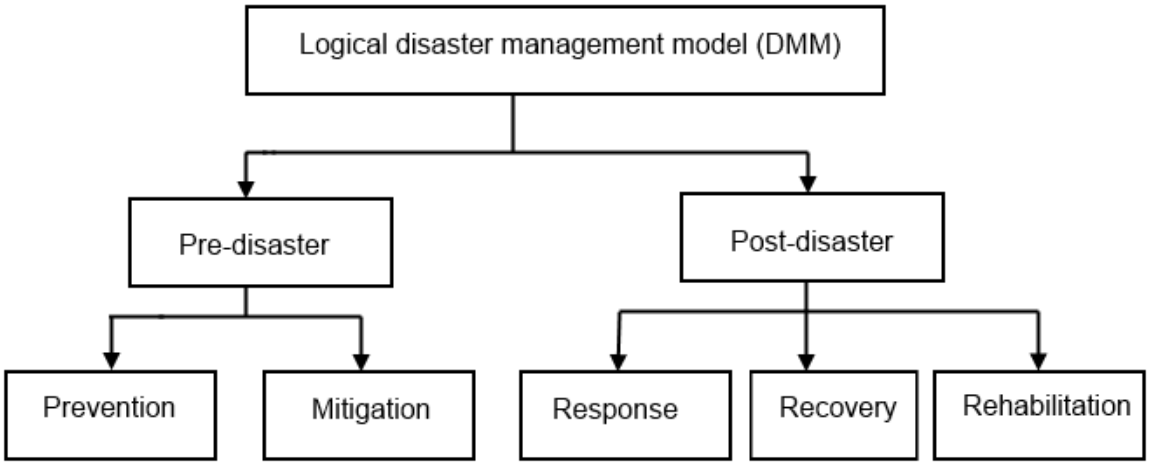
The United Nations, through its UN Safe*r*Guard programme, has developed a set of guidelines, training, and ICT-based tools to help munitions experts work with militaries and civilian DRM agencies to improve the safety and security of ammunition stockpiles. The ICT tools include a checklist of best practices for the safe storage of munitions, as well as a mapping tool that illustrates safe building and road setbacks from munitions storage areas. These tools can be accessed at www.un.org/disarmament/un-saferguard.

Source: Small Arms Survey and the UN Office for Disarmament Affairs.

B. Models of disaster management

DRM models can provide a useful framework to guide the planning efforts of disaster management agencies. The traditional models of disaster management branch into two phases, namely pre- and post-disaster. The pre-disaster phase generally comprises of two sub-phases: prevention and mitigation. The post-disaster phase can comprise the sub-phases of response, recovery and rehabilitation. These are exemplified in Diagram 1 below:

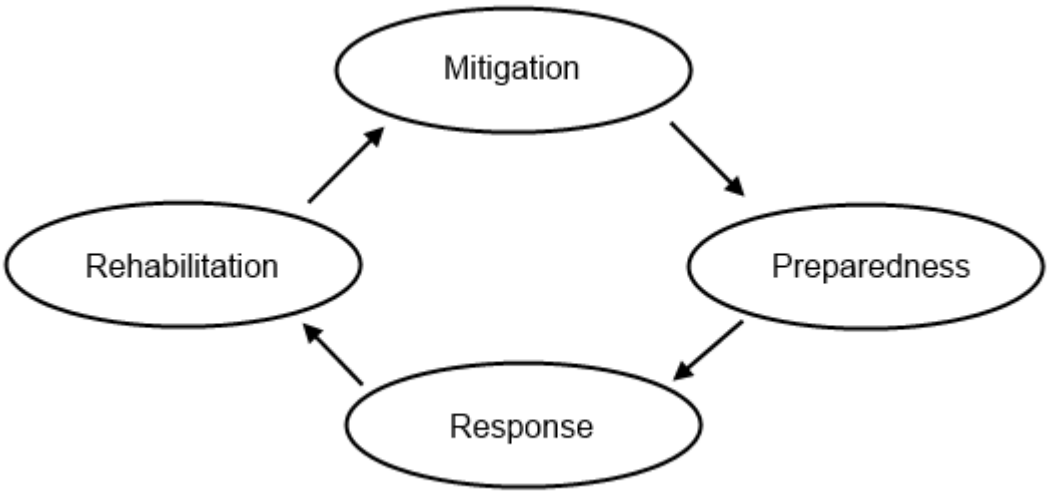
DIAGRAM 1
THE LOGICAL DISASTER MANAGEMENT MODEL



Source: Chirilov, L. and others (2006), "A Comprensive Conceptual Model for Disaster Management" Journal of Humanitarian Assistance.

Another representation of a traditional disaster management model, as shown in Diagram 2, is the four phase model: mitigation, preparedness, response and recovery. Although it is at the phases of response and recovery that disaster-related issues receive the most attention, mitigation and preparedness are being recognized as key phases that will save lives and contribute to sustainable social and economic development. Recent studies[1] have shown that every dollar invested in disaster preparedness not only saves lives, but can also save between US$ 4 and US$ 7 in humanitarian relief and reconstruction costs after a disaster occurs (UNESCAP, 2008).

DIAGRAM 2
DISATER MANAGEMENT CYCLE



Source: Tomasini,R. and Van Wasserhove,L (2009). "Humanitarian Logistics".

In the diagram above, "mitigation" considers all measures to avoid or reduce the adverse impacts of hazards and related disasters. In some cases, adverse impacts may be wholly prevented – for example through dams or embankments that eliminate flood risks and land-use regulations that do not permit any settlement in high risk zones. Very often, however, the complete avoidance of loss is not feasible and the task transforms to that of mitigating, or lessening the impact of an adverse event. Partly for this reason, the terms prevention and mitigation are sometimes used interchangeably. The mitigation function encompasses engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness.

"Preparedness" represents the "knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions" (UNISDIR, 2009). It is based on a sound analysis of disaster risks and good linkages with early warning systems.

1 Studies on this topic were conducted by the World Bank, the Asian Development Bank and the Government of the United States of America, and were cited at the Third Asian Ministerial Conference on Disaster Risk Reduction in Kuala Lumpur, Malaysia, in December 2008 (UNESCAP, 2008).

"Response" is considered to be "the provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected" (UNISDIR, 2009).

The "rehabilitation" phase, which also includes recovery and reconstruction, encompasses the restoration and improvement "of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors" (UNISDIR, 2009). Recovery programmes, coupled with the heightened public awareness and engagement after a disaster, afford a valuable opportunity to develop and implement disaster risk reduction measures and to apply the 'build back better' principle (Clinton, 2006).

C. Knowledge management approaches to DRM

The overall goal of disaster risk management is to keep humanitarian, socio-economic and environmental losses as low as possible. The management of information is foundational in the effort to achieve this goal. Information relevant to the practice of disaster risk management includes maps and data concerning the territory, information on hazard types, probabilities and timelines, protocols for emergency communications, and instructions on actions to be taken prior, during and after the impact of a hazard. As stated by the Pan-American Health Organization (PAHO), the efficiency of humanitarian responses to a disaster and the number of lives saved is directly related to the ability of an organization to compile, analyze, and distribute information (PAHO, 2005).

Stolzenburg (2007) argued that existence of information alone is not enough to ensure its effective dissemination. The possessors of the information must know what to do with it, and there must be appropriate governance systems to act on the information at the receiver's end. For example, in the context of the Caribbean, should scientific information indicating the on-set of a possible tsunami, or other hazard, be sent to a collaborator at a disaster agency, the effectiveness of that transmission will depend on whether the receiver is operational at the time the message comes in, and on whether the 'right' (or empowered) person at the corresponding office received the communication. The pre-established institutional structure and protocols which exist between institutions have a great impact on the effectiveness of information dissemination for DRM.

Thus, even when an early warning information system is in place and functional, there is no guarantee of the activation of preventive mechanisms. It is therefore possible for communities in the path of a hazard to still remain vulnerable, taking no action, until it is too late. Put differently, even when an ICT-based early warning system works from a technological perspective, it is necessary that pre-established procedures and protocols be in place to ensure that information is appropriately transmitted, received, and acted upon. In this regard, communities and institutions receiving ICT-based information must see such information as both credible and reliable, and must be trained, before the disaster event, as to how to respond. These complementary factors may not be technological but refer to the individual or institutional ability to make effective decisions based on the information received, and then to act accordingly.

The process of implementing the practices just described is at the heart of knowledge management. Knowledge management is the activity of helping an organization to create, capture, codify, store, share and apply knowledge effectively (Dorosamy and others, 2013). Knowledge management is not a new discipline, but activities that were once performed using paper, books, and analogy transmissions, have moved into the digital age. Information and communications technologies are the enabler of vast new capabilities in knowledge management, and knowledge management is the enabler of great new possibilities in disaster risk management.

BOX 2
CASE STUDY: THE INDIAN OCEAN TSUNAMI OF 2004

A review of the tragic Indian Ocean tsunami that occurred on Boxing Day, 2004, presents a warning of how inadequate knowledge management practices can obstruct early warnings of impending danger. It also demonstrates the potential for ICT technologies in a post-disaster scenario.

When a mega-thrust earthquake occurred under the ocean west of Sumatra, it was quickly detected by instruments located around the world. Seismologists at the Pacific Tsunami Warning Center in Hawaii predicted a major tsunami, but there were no direct channels to communicate a warning to policy-makers, local decision-makers and to the populations of endangered communities. Over 200,000 people were killed in the tsunami; perhaps tens of thousands would have been saved if there had been ICT systems available to spread the warning in time.

Following the disaster, ICT became recognized as an essential component of rescue and response operations. The widespread use of mobile phones and the internet facilitated relief efforts by enabling the coordination of humanitarian aid organizations and volunteers via SMS messaging and e-mail. These technologies enabled people to contact their families after the disaster, and the posting of digital photos on the internet was helpful in identifying injured people and lost children. Donations were requested through the websites of aid agencies and individual contributions were collected through electronic transfers in real-time.

Source: Dickson, 2005 and Stolzenburg, 2007.

III. The value of ICT in a DRM context

Information and communication technologies (ICT) have proven to be an accelerator of economic and social progress. They have contributed to economic growth by enhancing access to information and services, and by driving process efficiency and cost-cutting in businesses. Empirical studies on the impact of ICTs have found a positive correlation between the use of ICTs and business performance measured by labour productivity (UNCTAD, 2009). Innovative use of ICTs in various development sectors have also contributed to more effective delivery of services in agriculture, education, energy, government and health care.

In the context of disaster risk management (DRM), well-tested and implemented ICT-based knowledge management systems can help to decide what developments to monitor, what decisions to focus on, and what processes can be set in motion automatically, or in advance of an impending hazard. Knowledge management systems facilitate the collection, retrieval, dissemination, and storage of information, to ensure that it is available to those who need it, at the time and place it is needed. (Dorasamy et al, 2013).

Access to adequate infrastructure is a prerequisite for organizations and individuals to adopt and use ICTs. Over the past decade most countries of the Caribbean have seen great improvements in ICT infrastructure, due to both private and public efforts. This improved infrastructure can provide platforms for advanced tools to support DRM and knowledge management, which can, in turn, result in improvements to risk reduction practices and disaster response coordination efforts.

A. ICT in the disaster management cycle

ICT applications can be used to support all four phases of the disaster management cycle, as illustrated in Diagram 2 in Chapter II. These phases are mitigation, preparedness, response, and rehabilitation.

In support of the mitigation phase of the DRM cycle, ICTs can be particularly useful for the purpose of planning for settlements and other development. Tools, such as satellite imaging and geographic information systems (GIS), can be used to build models and prepare maps which illustrate areas that are at high risk for specific hazards, such as tsunami and landslides. This information can then

be used to ensure that new settlements are constructed in relatively safe areas, or to develop evacuation and response plans for existing settled areas under the threat of hazard.

In the preparedness phase of the DRM cycle, when it is clear that the arrival of a hazard is imminent, ICTs can be used to help predict the effect of the impact, and to preposition resources in locations where they will be most useful during the response effort. ICTs can also be used to facilitate the coordination of early warning systems, which can be used to alert the population of impending danger. For example, knowledge management systems can be used to facilitate chains of communication between the scientists who detect a hazard, and the disaster management organizations who must respond to it. This warning can then be communicated on to the affected populations, through a variety of technologies including mobile phones, ultra-high-frequency radio, warning sirens, and social and traditional media outlets.

During and immediately after the impact of a hazard – the response phase of the cycle – ICTs can enable communication between the disaster office and emergency personnel, as well as with members of the public, the media, and the government. ICTs can help the office to determine priorities, and to ensure that assistance is provided where it is needed. ICTs can also help to manage the massive load of information that comes into a disaster office during an emergency. This data may include information about of the affected area, data about shelters and the available transportation means, data about victims and relief personnel, available resources, and scientific field measurements (Li and others, 2012). Knowledge management systems can archive this information, so that it may be reviewed at a later time to develop an understanding about what practices worked, and where improvements need to be made.

During the rehabilitation phase of the disaster management cycle, ICTs can be used to procure the accurate, comparable, and appropriately scaled information that is required to perform damage and loss assessments (DaLAs) and for decision making regarding recovery and reconstruction. ICT systems can also be used to monitor and evaluate the financial and physical progress of the recovery effort.

BOX 3
CASE STUDY: EARLY WARNING SYSTEM ON MONTSERRAT USING THE COMMON ALERTING PROTOCOL

The people of Montserrat live in the shadow of the Soufriere Hills Volcano, which most recently began erupting in 1995, forcing the evacuation of the southern two-thirds of the island. Though it has been relatively quiet since 2010, the volcano's potential to shower the island with pyroclastic ash remains a constant threat. Therefore, a robust and highly redundant early warning system is a crucial piece of infrastructure for the people of the island.

A project to upgrade the early warning systems in Montserrat was initiated in 2010 by the territory's Disaster Management Coordination Agency (DMCA). At the time, there already existed an eight-site siren system, and a separate radio alerting system. However, there was a need to tie the administration of these two alerting methods together, while building additional communications channels into the system. The DMCA opted to implement a system based on the Common Alerting Protocol (CAP), which is a data exchange standard used to build ICT platforms for propagating early warning alerts through various output devices, including sirens, radio, email, SMS and cell broadcasting. The platform would accept input through administrators that could be logged in via computers or smart phones, and potentially from administrators on another island if systems on Montserrat were down.

The DMCA faced a number of challenges in implementing this project. They lacked the internal capacity to assess the situation from a technological standpoint, or to design a solution. They also lacked ICT project management and quality control abilities, and the government IT department had no experience or interest in alerting systems. Costs were prohibitively high, and vendors desired to sell bigger, more expensive systems than what was required. There was only one telecoms service provider on the island, and that provider was unwilling to support a cell broadcasting solution.

The system has been installed and in place since 2012, although there are still some outstanding issues. The inability to send mass text messages alerts is still a problem that needs to be resolved. The DMCA also struggles with the limitations of its human resource capacity. As a public agency on a small island, with limited technical expertise to draw on, managing the system from an ICT perspective has proven difficult.

Still, though there have been no large eruptions in the time since the new early warning system came on-line, the people of Montserrat are safer for its presence.

Source: Montserrat Disaster Management Coordination Agency.

B. ICT applications and infrastructure for DRM

The array of ICT applications and infrastructure that are well-suited to the disaster risk management context can broadly be divided into categories of communications technology, tools for collaboration, and systems related to mapping and sensing.

1. Communications technology

a) Radio

Radio technology has long been a staple of disaster management communications systems. Ultra-high-frequency (UHF) radio is commonly used as a medium to support voice communications. UHF radio has the advantages of being able to work over relatively long distances, with little needed in the way of infrastructure. UHF is widely used by disaster management offices within the Caribbean, and there are specific channels reserved for communication in emergency situations. UHF signals generally work on a line-of-sight principal, but can be bounced against the ionosphere for longer distance communication. Crucially for the Caribbean situation, UHF is well suited to communications between islands.

In addition to professional users, there is a large community of amateur radio operators throughout the world, who have the training and skills to provide emergency communication facilities during an emergency. Several million volunteers have taken a technical examination and received a radio transmitting license from their national administration, which permits them to operate a personal amateur radio station on authorized bands of frequencies. Amateur radio operators are experienced in improvising antennas and power sources to quickly establish lines of communications. Annual 'Field Days' are held in many countries to practice these emergency improvisational skills (APCICT, 2010).

Since 1925, there has been a federation of these National Societies known as the International Amateur Radio Union (IARU). IARU has a Memorandum of Understanding with the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), and assists in mobilizing volunteer amateurs to operate radio communication networks in support of relief efforts. Amateur radio operators have proven a valuable resource for disaster communications in the past; after the Indian Ocean tsunami of 2004, amateur radio operators provided, in many cases, the only means of communication that could reach hard-hit areas and isolated island populations. The Caribbean has its own isolated island populations, and amateur radio should not be written off as a means of reaching them in the event of a disaster.

b) Mobile phones

The availability of mobile phones has greatly increased over the past decade, and the technology now represents an opportunity to be in direct, two-way contact with a broader population than has ever been possible before. Mobile phone technology has much potential as an early warning system that can be used to alert a populace of impending danger. It also shows value in a post-disaster situation, when mobile communications can be used to organize response and recovery efforts, in close coordination with those in need of services.

i) SMS messaging

Though mobile technology supports voice, text-based, and broadband data communications, it is primarily the text-based communication methods that are of interest in the context of public communications as part of a disaster response initiative. This is because text-based communications are more scalable than broadband or voice communications in the context of an emergency, when cellular networks can easily become clogged with high-bandwidth traffic as many users attempt to use their phones at the same time.

Simple messaging service (SMS) messages provide a messaging capacity with far lower bandwidth requirement than voice or data messages, and SMS messages will frequently be able to get through when voice services are not available. Emergency Alert Australia is an example of an SMS-based warning system, although it is combined with a voice messaging based system for providing alerts over landline telephones as well. Emergency Alert Australia maintains a database of SMS numbers that

are registered to geographic locations, and sends out warning message to all numbers registered to an area when that area is at risk.

The overhead and difficulty of maintaining such a database of numbers is one drawback to using SMS alert systems. Another problem is that SMS messages are limited to 140 characters per message, and it can be difficult to squeeze a complete and coherent warning message into such a limited string of text. SMS messages are also targeted by phone number, rather than by geographic location, so tourists in an area, with a phone number from a distant location, would not receive a danger warning on their phone because their phone number would not be in the database of the local disaster management agency.

Further, it must be recognized that even low-bandwidth SMS messages run into network capacity problems when used at a large scale. SMS messages are a form of one-to-one communication, and so the broadcast of a message to a large population can result in the insertion into a network of thousands or tens of thousands of messages, swamping the ability of the network to handle the traffic and resulting in a large number of failed message deliveries. Fortunately, new technologies — such as Cell Broadcasting (CB) — are emerging that can overcome this limitation.

ii) Cell broadcasting

Cell broadcasting (CB) has several advantages over SMS, particularly for early warning systems. Instead of being a one-to-one communication system, like SMS, CB sends messages on a one-to-many basis. This means that a single message inserted into the network can be received by a large number of people, circumventing the problem of network congestion. Cell broadcasts can also be targeted to geographic regions, instead of by phone number – so that tourists from faraway places *will* be able to receive warnings targeted to the area that they are in (APCICT, 2010).

Cell broadcasting shows impressive potential as an early warning system, but policymakers should also be aware of the limitations of the technology. For instance, to receive alerts through CB, the user must have a CB-enabled phone that is switched on and set to receive the CBs. Moreover, CB is not invulnerable to hazardous events - disruption of the mobile telecommunication system would hamper optimal functioning of the CB system as well. Thus, it is necessary that CB technology be used in conjunction with other methods of early warning, such as the use of warning sirens and of messages broadcast over radio.

Cell broadcasting is now widely used in the United States as part of the Commercial Mobile Alert System (CMAS). It is being assessed and tested in developing countries including Bangladesh and the Maldives. According to representatives of their respective national disaster management agencies, CB is also currently being assessed in Jamaica and Trinidad and Tobago, but it is not known to have been implemented yet on a wide scale in any Caribbean countries.

Cell broadcasting technology must be rolled out in close cooperation with mobile network operators, and difficulty in working with these operators was cited by some DRM agency representatives as one factor holding back adoption of this technology. However, it was noted in the expert group meeting that support for disaster communications is mandated in many telecom licensing schemes, and it was suggested that this could be used as leverage point to bring telecoms on board with the implementation of cell broadcast technology (ECLAC, 2013).

BOX 4
THE LIMITATIONS OF MOBILE PHONE PENETRATION IN THE CARIBBEAN

The Caribbean reports some of the highest mobile service penetration rates in the world. According to data released by the International Telecommunications Union (ITU) in 2011, mobile phone subscription rates in some islands are close to 166 per cent, as compared to 128 per cent in Europe, 104 per cent in the United States of America and 76 per cent in China. Information presented in the World Economic Forum's (WEF) Global Information Technology Report (GITR) 2013 suggests that mobile network coverage across the Region averages between 95 per cent and 100 per cent.

These high mobile services coverage and uptake rates distinguish the Caribbean from other regions at a similar stage of development. Anecdotal evidence confirms that mobile device adoption is indeed widespread, and coverage from service providers is quite broad. However, there are reasons to be sceptical of the high rates of reported mobile phone market penetration.

Though the reported percentages seem to suggest that the entire population has access to one or more mobile phones, the reality though is quite different. In many cases the uptake of subscriber identity module (SIM) cards or mobile phones is measured as high, not just because one person may own more than one phone, but also because tourists may purchase SIM cards and then leave the area, though they would still be counted in the officially reported statistics. A representative from the Caribbean Association of National Telecommunications Organizations (CANTO) has stated that new approaches to measuring phone penetration – counting active SIM cards, rather than all SIM cards – are under consideration, and may result in reduced over-counting of mobile phone users.

It must be recognized that, in spite of the reported ubiquity of mobile phone technology, members of some of the populations most vulnerable to disaster may still be without handsets. These populations include poor people, the elderly, as well as children.

Additionally, for a handset to be usable in an emergency situation, it must be charged up and turned on, and the user must be familiar with its messaging capabilities. This limitation demonstrates that, in practice, no one ICT channel or communication burst will reach an entire population. A multi-channel approach inclusive of more traditional systems, such as siren systems and radio, will be required as means of maximising the possibility of reaching endangered populations with potentially lifesaving information. Members of the public are also likely to be more responsive to early warning alarms if messages are transmitted simultaneously and continuously through different mediums and channels.

Source: Report on the expert group meeting on information and communication technologies for disaster risk management in the Caribbean, ECLAC 2013.

c) Social media

Social networks, such as Twitter and Facebook, represent a newly emergent channel of communications that has gained great social prominence over a relatively short span of time. These social media channels, and the vast audiences that can be reached by them, represent a valuable opportunity to promote the goals of DRM. A 2011 report on Social Media and Emergency Management offers an in depth look at the potential DRM applications of this new technology, and offers three predominant reasons that emergency managers should engage with social media:

1) Meeting and managing citizen expectations
2) Increasing situational awareness
3) Crowdsourcing and leveraging citizens as force multipliers

The report cites a survey conducted in 2010 by the American Red Cross indicating that many internet users already have an expectation that they should be able to use social tools to engage with emergency response organizations. The report concluded that "[t]o the extent that citizens have these expectations, there is significant value to be gained by an organization that establishes a social media presence and actively sets expectations of its response capabilities through active dialogue with its constituents." (Wardell and Su, 2011)

Disaster management organizations that use social media, however, must consider that following an event, organizations can be bombarded with questions and requests for assistance through Twitter, Facebook and other social media channels. Procedures need to be in place beforehand to determine how these queries should be handled, and expectations need to be communicated to the social media audience. There should also be a clear accountability as far as approving the release of messages that may have a reputational impact on the disaster management organisation or on the government.

In light of the reputational importance that can be attached to social media communications, social media governance policies should include determination of who is responsible for the release of information through social channels and should establish standard procedures for ensuring that these messages are appropriately vetted. In addition, these policies should cover both how social media is used on a day-to-day basis, as well as how social media tools are to be used in early warning situations, and in communicating information to the public in the hours, days and weeks following a disaster.

BOX 5
TWITTER AS A TOOL FOR COMMUNICATIONS AND EARLY WARNING

Twitter (https://www.twitter.com) is a social network that is quite popular in the Caribbean. Twitter account holders use their computers and mobile phones to compose and transmit "tweets" – small messages of up to 160 characters. They read tweets from users that they are "following" and, at times, "retweet" messages by passing them on to their own "followers".

National disaster management offices can use Twitter to propagate warning messages to a wide audience in a timely manner. In cases of earthquake, landslide, floods, and hurricane, and especially in the event of a tsunami, Twitter's ability to spread messages quickly and widely can make it a powerful tool that saves lives. Twitter can also be used in a post-disaster situation, to publicize the availability of relief services and to act as a gateway to receive requests for emergency assistance.

Twitter users, as a group, tend to be among the most socially connected users of the internet. Members of the media, in particular, are frequently plugged in to Twitter, and can be leveraged to amplify early warning messages by passing them along through a broad range of channels.

However, warning messages are not effective if they are not received. So if a disaster management office has but a small Twitter following, an important warning message can fail to "go viral" if it is not initially spread to a wide enough audience. Thus, to make effective use of Twitter as an early warning tool, disaster offices should aspire to be no more than one retweet away from every active Twitter user in their jurisdiction. Building a large and active group of followers is one way to create this capability. It is also important to be followed by those who themselves have a wide following, such as local celebrities or other government offices.

The Twitter feed of the Trinidad and Tobago's Office of Disaster and Preparedness Management (https://twitter.com/odpm_tt ,Twitter handle: @ODPM_TT) appears to be the most popular Twitter feed of any disaster management office in the Caribbean subregion, with over 11,500 followers at the time of this writing. One of the ways the @ODOM_TT account has built a following is by tweeting a weather forecast every morning. This regular and useful service has helped @ODPM_TT to build a following that may prove to be a great value in the event of a disaster.

Source: Authors' compilation.

2. ICT Tools for coordination and collaboration

a) WebEOC

WebEOC (http://www.esi911.com/esi/) is a commercial product that is used by several Caribbean disaster management offices, including the British Virgin Islands, the Cayman Islands, and Trinidad and Tobago, as well as by many other organizations throughout the world. The web-based emergency operations centre serves as a central information hub for the timely management of information related to ongoing events.

b) Crisis mapping tools

In recent years, there has been an emergence of volunteer-organized, online networks that provide mapping and data collection services to aid in disaster response efforts. The International Network of CrisisMappers (http://crisismappers.net) is one such community of volunteers. The volunteers, who have varying levels of training and experience, collect and analyze data using a variety of freely-available tools. This information is then relayed to responders on the ground in the disaster-affected area.

Ushahidi (http://www.ushahidi.com/) is an example of one tool used by crisis mapping networks. It is an open source project for use in post-disaster situations that is used to gather information drawn from public contributions through a number of sources, including SMS, email, Twitter, and other web-based and social media applications. The collected public information is then filtered and displayed through Google Maps for use by emergency responders, and is used to direct aid to the places where it is needed most. The "crowdsourcing" aspect of this application is valuable because it can generate a much broader set of information in times of emergency than what available through strained and limited governmental sources. Ushahidi was used after the 2010 Haiti earthquake, where it processed nearly 40,000 individual reports from the public, covering over 4000 unique events.

3. Mapping and remote sensing systems

Remote sensing refers to the process of recording information from sensors mounted either on satellites or aircrafts. Earth observation satellites, for example, can be used to view the same area over long periods of time and thus make it possible to monitor environmental change, human impact and natural processes. This helps scientists and planners create models to simulate trends observed, and offer projection for the future. This data is also used by national meteorological agencies, who are often responsible for initial warnings concerning weather-related disasters (storms, floods, cyclones). In most countries, these agencies also rely heavily on ground-based networks of radars.

a) Satellite imaging

Satellites provide information for wide geographic areas, including oceans, and can improve forecasting to make warning systems more efficient. Increasingly, countries are coming to rely on satellite data which allow nearly continuous observation of global weather. Almost all OECD countries have national meteorological agencies, and all G20 countries have satellites in orbit (OECD, 2012). However, many of the small countries of the Caribbean do not have direct access to satellite resources, and are dependent on systems provided by other countries and international organisations.

The United Nations Institute for Training and Research (UNITAR) offers countries access to satellite data through the UNITAR Operational Satellite Applications Programme. According to UNITAR, "UNOSAT is a technology-intensive programme delivering imagery analysis and satellite solutions to relief and development organisations within and outside the UN system to help make a difference in critical areas such as humanitarian relief, human security, strategic territorial and development planning. UNOSAT develops applied research solutions keeping in sight the needs of the beneficiaries at the end of the process." Unfortunately, a review of maps created through the UNOSAT mechanism indicates that most Caribbean countries have not been taking advantage of this resource for post-disaster analysis (UNITAR, 2013).

b) Drone-based aerial imaging

In post-disaster situations where highly localized, inexpensive aerial photography with a quick turn-around time would be advantageous, disaster management offices may consider the use of unmanned aircraft, or drones, as a means of information collection. Military reconnaissance drone systems could easily be adapted for this purpose. Additionally, commercial, off-the-shelf drone systems, such as the DJI Phantom and the Parrot AR.Drone can now be purchased for well under US$ 1000 (Lardonis, 2013). Disaster management professionals would need significant training in the use of these systems prior to an emergency, although the increasing popularity of drone systems with hobbyists could make the development of an amateur support network for this technology an intriguing possibility.

4. Geographic information systems (GIS)

Geographic information systems (GIS) represent the merging of cartography and database technology. The use of GIS, combined with data obtained through remote sensing, has allowed a more comprehensive mapping of disaster risks to better support decision-making and improve coordination among agencies. For example, when hazards are mapped against the location of houses, schools, critical infrastructure (hospitals, airports), power lines, storage facilities, etc., plans for mitigation, preparedness, response and recovery can be formulated.

a) Usage of GIS

GIS can be used in all phases of the disaster management cycle. It can be used to identify high risk areas and prioritize them for mitigation activities. In the preparedness phase, GIS can be used to identify evacuation routes, shelters outside the hazard zone, and resources available (people, equipment, supplies) in the area and its vicinity that can be mobilized in the event of a disaster. For response, GIS is useful in prioritizing areas for search and rescue, and planning the route for evacuation, delivery of relief supplies and medical assistance. In recovery, GIS can be used to plan reconstruction (APCICT, 2010).

GIS systems are already in wide use across the Caribbean. Jamaica, for example, has an office responsible for the implementation of GIS systems throughout the government, which, as part of their mandate, supports Jamaica's Office of Disaster Preparedness and Emergency Management (ODPEM). ODPEM has integrated GIS into vulnerability mapping and scenario planning, and also has its own emergency GIS unit. In case of any major event, GIS specialists are pulled in from across the government to form an emergency team to do data analysis (ECLAC, 2013).

BOX 6
CASE STUDY: THE USE OF GEOGRAPHICAL INFORMATION SYSTEMS FOR IDENTIFYING TEMPORARY DEBRIS MANAGEMENT SITES IN BARBADOS

After Tropical Storm Tomas passed Barbados in 2010, it was recognized that better temporary debris management sites (TDMS) were needed to facilitate the staging and sorting of storm-related debris. A major concern was the need to reduce the environmental and public health hazards associated with the inappropriate treatment and disposal of debris.

It was determined that geographical information systems (GIS) could be used to locate inactive quarries on the island that could be used for TDMS, and to help evaluate their suitability to the task. GIS was used to identify 44 quarries on the island that were visited to determine their suitability to the purpose. However, the national disaster office was challenged in compiling and storing the data collected during the quarry visits, due to limited in-office infrastructure, particularly with regard to GIS. Thus, other systems were used to winnow the 44 inactive quarry sites to a list of 16 that were identified as suitable for TDMS, of which six were ultimately chosen for the purpose.

This experience highlighted the need for improved infrastructure and human resources capacity as a requirement for making the best use of GIS, and of ICTs as a whole. It also suggests the need for having specialized centers of excellence on GIS technology within government, as in the Jamaican model, which can then lend their expertise to disaster management offices and other agencies on an as-needed basis.

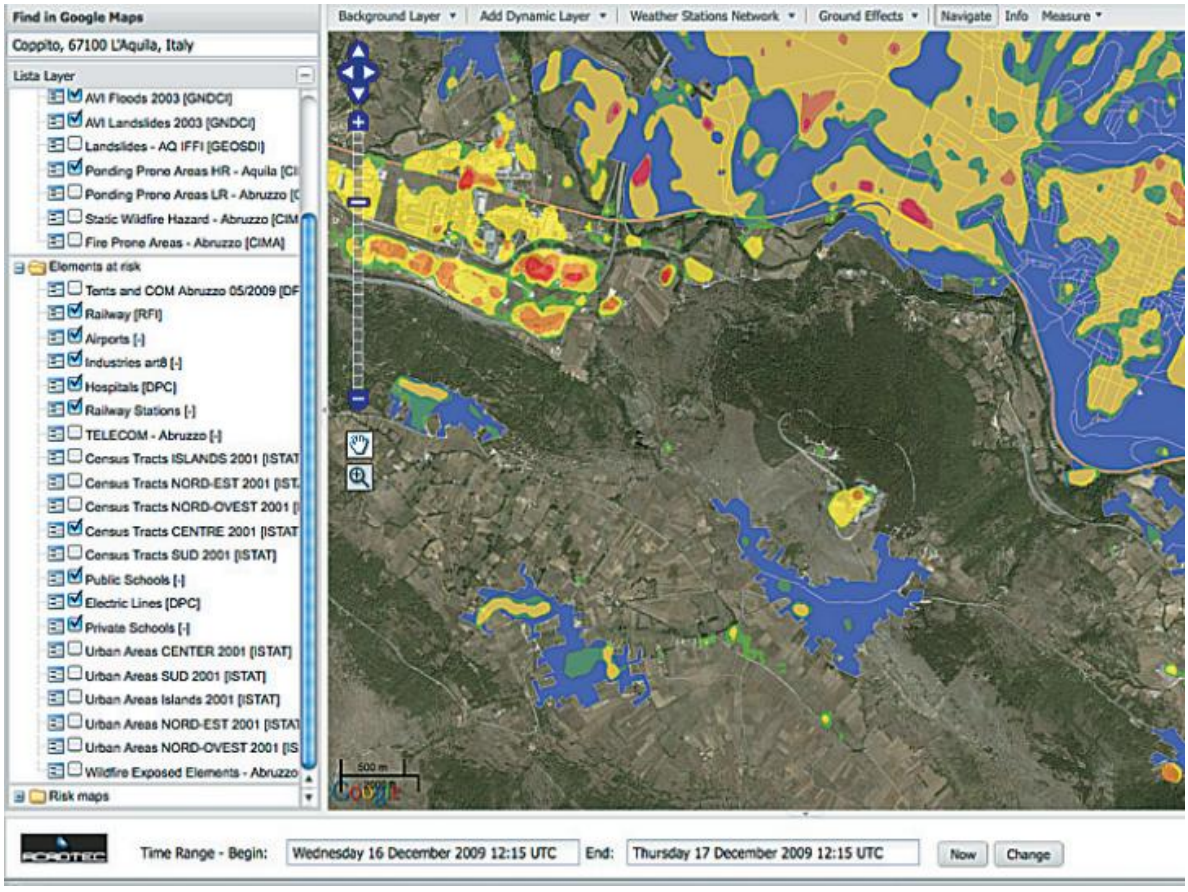
Source: Barbados Department of Emergency Management.

b) Web mapping systems

In the past, GIS systems, such as ArcGIS, have been expensive to implement and have required highly specialized skills. However, in recent years an array of new "web mapping" tools have come on the market, notably Google Maps (http://maps.google.com), Bing Maps (http://bing.com/maps), and Open Street Map (http://www.openstreetmap.org). These tools support many of the capabilities of the older generation of GIS systems, but provide a less complex interface that is more easily embeddable in other web-based tools. Many of the difficulties of hosting GIS systems are also removed from the equation, as these systems are hosted on the servers of the organisations that have developed and maintain them. At low usage levels, these systems are available free of charge, though more intensive usage does come with a cost.

These systems represent a broad simplification and democratization of GIS technology, and should be strongly considered in the implementation of new tools for DRM. The Ushahidi platform, discussed above, is one example of a product built around Google Maps' capabilities. Another is DEWETRA, which is a system designed and operated by the Italian government for flood and wild-fire forecasting. The United Nations Development Programme (UNDP), the Caribbean Institute for Meteorology and Hydrology (CIMH) and the Italian Ministry of Foreign Affairs have partnered to make DEWETRA available to Caribbean countries.

FIGURE 1
DEWETRA – A FLOOD FORCASTING TOOL THAT UTILIZES GOOGLE MAPS



Source: http://63.175.159.26/erc/lib/pdf/Revised%20Dewetra%20Guide_June%202012.pdf.

IV. Analysis of ICT for DRM in the Caribbean

The empirical aspect of the study took the form of a survey including interviews, where possible, conducted with national and subregional agencies and departments responsible for DRM in the Caribbean. The survey was used to determine how integral ICT is to their operations, as well as the existing level of sophistication of use. It also aimed to determine the effectiveness of use of technologies within the Caribbean, so that gaps in information and communication strategies can be determined, in order to make recommendations on possible developments that should be sought.

A number of limitations were placed on the study due to the resource constraints. A limited budget was available to the effort, and so travel and in-person observation and interviews with key personnel across the region were not possible. Data gathering was therefore limited to the development of an on-line survey, which was followed up by a phone interviews to clarify responses given and to solicit responses where no responses were initially forthcoming.

The survey targeted the 24 national disaster management offices within the region. A two week period was given for survey participants to respond and, after that time, there were 16 responses from 13 national disaster management offices completed the survey. For the purpose of analysis, multiple responses from disaster management offices were compiled into single responses. The data was collected using an on-line tool and the assessment of the survey results is presented below. The full list of survey questions can be found in the Annex.

A. Design of the survey instrument

To facilitate the assessment of feedback provided by target countries, an e-Readiness Framework has been employed. The framework, which was developed by INFOCOMM Technologies Ltd., assesses the current level of sophistication of ICT use within a sector, industry or organisation, and the preparedness of a sector, industry or organisation to use ICTs to achieve operational effectiveness and efficiency gains, as well as to improve information management, dissemination and collaboration capacities.

In order to arrive at an overall picture of the current opportunities and issues regarding ICT use for DRM, as per the framework, the analysis of the data was segmented into five core areas: business environment, governance, human resource capacity, psychographics and infrastructure.

The area of "business environment" considers the external conditions in regard to ICT that the national disaster response offices operate under. Survey questions 8, 11, 42 and 47, which can be referenced in Annex 2, are examples of questions asked to solicit information in this area of the survey. Broadly, these questions inquired about ICT capabilities of partner organizations, and about the challenges faced in collaborating with outside entities. One criticism of the survey that came up in the expert group meeting is that this area did not adequately encompass the role of the public as a stakeholder in DRM, and that greater emphasis should have been placed on the public's capacity to interact with ICT systems in a DRM context. There is a tendency for the effectiveness of technology to be assessed by persons who have extensive experience with ICT, and so vulnerable populations without access to ICT technologies can be overlooked.

The questions under area of "governance," including survey questions 4, 14, 15 and 36, sought to determine the level of governance structure which is in place with regard to national DRM agencies. The questions go further to extract how agencies define and govern their own ICT usage in the context of the national and sector guidelines which may exist. These questions also sought information on the status of National Disaster Plans, how these plans addressed issues related to ICT, and how deeply ICT requirements were integrated into national legislation on disaster planning.

The questions on "human resources capacity" tried to gauge the overall capability of DRM staff in regard to the use of ICT tools. Some of the survey questions that covered this issue were 21, 39, 40 and 45. Broadly, these questions sought to determine whether it was felt that staff had sufficient proficiency with ICT tools to be able to use them throughout the four phases of the disaster management cycle (see Diagram 2 in Chapter II).

The fourth area of the e-Readiness Framework covers "psychographics", which entails the culture and mindset of an organization. In this case, the questionnaire specifically sought to glean the mindset of the various DRM organisations on the issue of ICTs and their implementation. More generally though, these questions sought to discover their openness to embracing innovation, new approaches and enhanced techniques within the discipline - which in the current period are generally driven by or take advantage of recent advances in information and communication technology. Questions 3, 18, 38 and 49 were examples of psychographics-related questions. They asked about insitutional support for ICT – in the form of budget and champions in senior management – and about overall attitudes within the office toward ICT practices as they are applied to DRM.

Questions in the area of "ICT infrastructure" included 6, 20, 26 and 27. These questions sought to ascertain what current ICT infrastructure - both internal and external to the organization - are in use by various DRM agencies. This area covers hardware, software, and internet-based services, and seeks to understand how this infrastructure is used in the different activities of the DRM organization.

B. Analysis of Survey Results

The responses to the questions pertaining to each of the five areas were analysed to give insight into the current state of subregional disaster management organisations with regard to that area. This picture was then drawn upon to build conclusions and recommendations that are presented primarily in the final chapter of this study.

1. Business environment

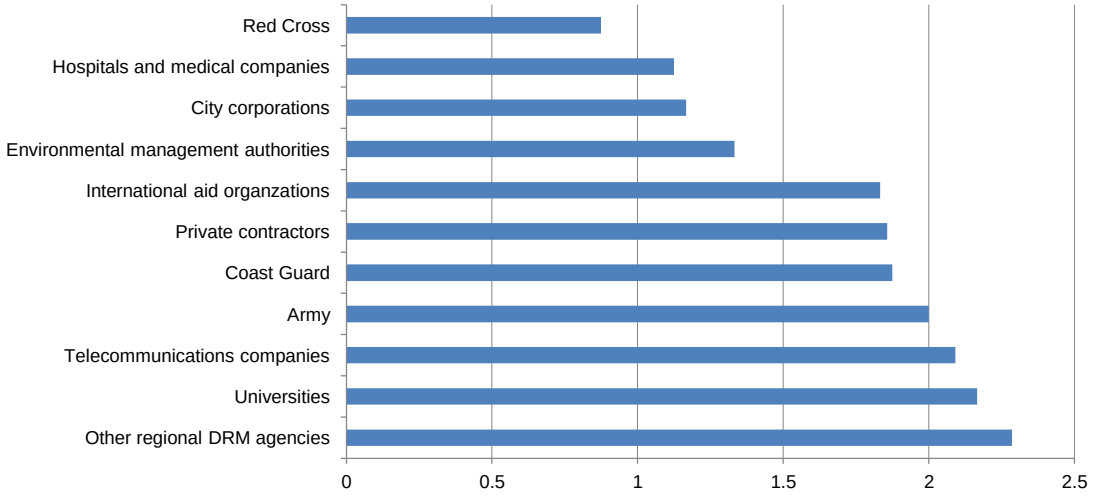
Consideration of the business environment examines factors which are external to the organisation, but which have an impact on the organisation's return on ICT investment. This category looks at aspects such as the ICT capacity of collaborator organisations, the general ICT savvy of the national population, and the overall level of ICT sophistication within the society. This analysis can aid strategists in determining which structural ICT interventions will be advantageous to implement to enhance sector or organizational effectiveness.

a) Perceived ICT capabilities of collaborative agencies

Survey participants were asked about their perceptions of the ICT capabilities of a range of types of collaborators that they interact with, and a weighted average of their responses is indicated in Figure 2. Participants rated their counterparts in other DRM offices in the Caribbean region most highly. This is cause for optimism, but may also reflect familiarity and a shared understanding of underlying DRM requirements for ICT. Universities also scored relatively high, as did armies and telecommunications companies.

The Red Cross scored poorly in this metric, as did hospital and medical companies, and city corporations scored poorly. This may reflect a lack of human and financial resources, or lack of focus on ICT within these organizations, and, in the case of the medical organizations, may reflect additional difficulties inherent in the use of ICT for health care.

FIGURE 2
PERCIEVED ICT CAPABILITY OF DRM COLLABORATORS
(Weighted average score[a])



[a] Graph methodology: The ratings that survey participants assigned to the various collaborators were scored based on point values assigned to each of the possible answers. Responses of "adequate" were assigned one point, "above average" were assigned two points, and "expert" were assigned three points. Responses of "not capable" were assigned negative two points, and responses of "not sure" were not included in this calculation. These scores were divided by the number of responses to determine a weighted average score.

b) Information sharing among agencies

The ability to share information among different agencies is an important factor in the successful implementation of ICT solutions. When asked "Do the applications of different agencies involved in ICT share information?" two thirds of the responders answered that they do. This indicates that information sharing among agencies is indeed a common characteristic of the DRM environment. This is an extremely important environmental factor which impacts the usefulness of the uptake of ICT, and may indicate the presence of the so-called "network effect" – a theory that states the usefulness of any technological network is exponentially proportional to the number of participants using the network.

Moreover, the information sharing nature of the sector as reported by respondents, means that the sector is pre-disposed to benefitting from shared information and collaboration platforms which may be developed; this is in contrast to other sectors in which a culture of information silos exists. It bodes well for the potential of ICT in DRM because it means that the intense expenditure of effort required "breaking the silos" may be unnecessary. Thus, it is recognized that DRM may have a natural advantage in ICT adoption due to its pre-existing culture of information sharing.

Overall positive responses notwithstanding, respondents did outline some of the challenges experienced during collaboration with other DRM organisations. Some of these challenged include a lack of documentation of protocols and processes, the absence of standardized sets of baseline data, lack of standardization of forms, lack of geo-referenced data, and deficiencies in ICT equipment and infrastructure.

In-depth discussion with DRM executives revealed that while some of the technical issues mentioned above are quite challenging, much of the difficulty in data sharing is related to management issues. The information sharing that does occur frequently happen on an informal level, as it can sometimes be difficult to obtain formal sign-off between agencies in a timely fashion.

Participants indicated that there is, at times, a reluctance to share information even between government agencies, let alone at a regional level. This may be due, in part, to territorialism among ministries, but may also be due to legitimate concerns about privacy and data security. In contrast to this trend, however, the director of the Department of Emergency Management in Barbados indicated that her agency is aided by legislation which mandates that collaborator organizations which hold information pertinent to emergency planning are required to share it with her office.

c) Civilian populations and ICTs

DRM agencies were asked about their perceptions of the ICT sophistication of their respective communities. This was an attempt to determine the degree to which citizens are disposed to the use of ICTs for receiving communications on disaster related issues, and whether citizen populations could be engaged, through ICTs, to assist in the overall national DRM effort. When asked whether or not agencies believed that their internet communication methods had increased their organisation's effectiveness in citizen outreach efforts, approximately 70 per cent indicated that they did.

"Increasingly the public are using the internet as a source of information," one responder wrote. "Websites and a robust social media presence [are] necessary to reach the ever increasing percent of people who consume information this way." Another wrote, "The use of the Internet has allowed us to provide up-to-date information, plans, press releases and [a] wealth of other information to our key customer group. Additionally, the use of social media provides [an] avenue of feedback from the general population, often in real time or near-real time during some incidents / events." A third responded, "The website is the portal for signing up to the Anguilla Warning System and [for] downloading the applications, and as such is important to increasing our deparment's outreach."

2. Governance

The area of governance encompasses a view of an agency's strategies, plans, rules, procedures and guidelines, and the level of formal definition of these elements. This pillar also assesses the ability of sector administrators, ICT professionals and other stakeholders to successfully implement policies and monitor compliance, within a structured environment, so as to achieve pre-defined desired outcomes.

For an ICT system to be effective, it must model and interact with a real environment – conforming to predefined triggers or business rules set up by the organisation. For an example, there might be a business rule in place that says "Send out text messages to [*list of recipients*] when [*relevant authority*] indicates [*# of hrs*] are left a before [*type of storm*] makes land fall". When real systems are well defined, they can be efficiently and effectively modelled using ICTs. Conversely, adding ICTs to a chaotic environment inevitably adds to the chaos.

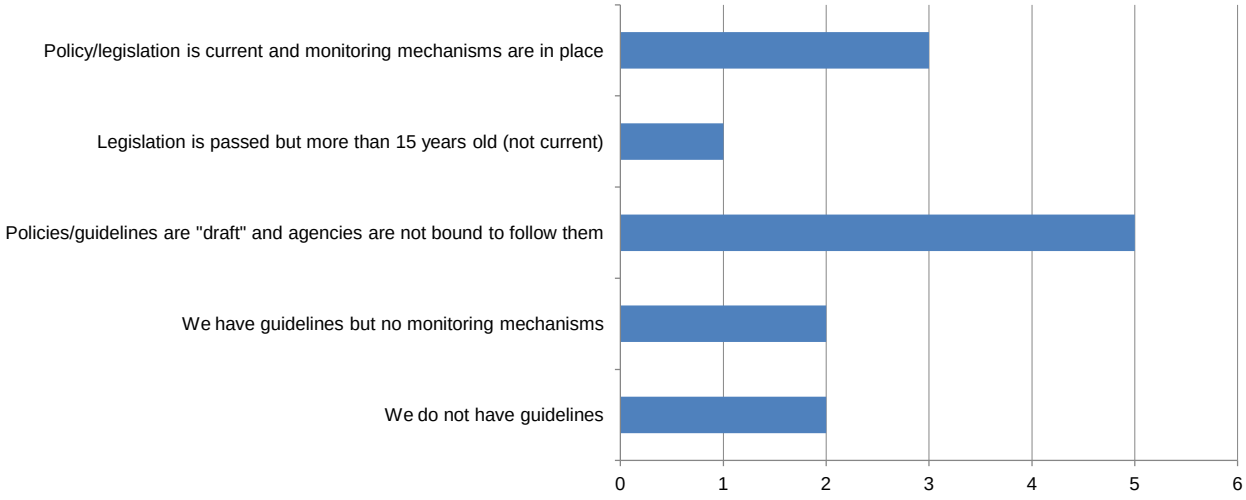
a) DRM guidelines and compliance

Based on the responses to the survey, it is clear that some structure does exist in the region with regard to disaster management. However, the level of formality is quite variable, and full compliance with official procedures is rare.

At the organisational level, more than 75 per cent of responding DRM organisations reported that there was indeed a clear set of rules and metrics that governed events, such as when early warning alerts are triggered. Approximately 70 per cent indicated that there were rules which govern how information received by the organization during or just after a disaster is to be utilized, and a similar percentage indicated that there were pre-defined budgetary or business arrangements with collaborator agencies and/or with the private sector, which could be activated during disaster response.

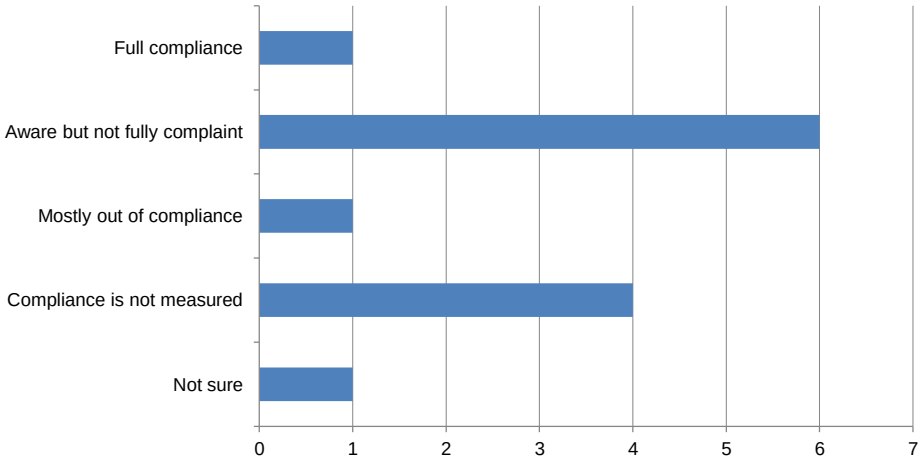
At the national level, 80 per cent of countries reported that an official and current National Disaster Preparedness/Response/Management Plan is in place. However, only one fifth of these indicated that the national policy guidelines were current and had an appropriate monitoring system (see Figure 3 below); only 6 per cent felt that there was full compliance with national guidelines (see Figure 4 below).

FIGURE 3
EXISTENCE OF CURRENT NATIONAL DRM GUIDELINES AND MONITORING MECHANISMS
(Frequency of answer)



Source: ECLAC survey on ICT for disaster risk management in the Caribbean.

FIGURE 4
LEVEL OF COMPLIANCE WITH NATIONAL DRM PLANS AND POLICIES
(Frequency of answer)



Source: ECLAC survey on ICT for disaster risk management in the Caribbean.

One DRM office representative questioned the soundness of this question on national DRM plans however, noting that there is a distinction between a disaster risk reduction plan and disaster management plan. It was argued that a disaster management plan focuses on response. Disaster risk management, on the other hand, embraces mitigation and prevention and thus entails something other than emergency services and the existence of a warden system. Thus, it was asserted that an affirmative response to the question may be misleading.

Feedback from another respondent regarding legislation was that legislation that is 15 years old is not necessarily outdated, since planning is typically done on a 10 to 15 year horizon. These sentiments notwithstanding, there seemed to be a consensus among DRM Executives that most disaster legislation in the region simply establishes the national mechanism and framework (e.g. establishing the existence and powers of the Disaster office) rather that addressing specific policy matters. Generally, it was accepted that the existing legislation in Caribbean territories is frequently not up to date, and does not take into account the full potential of modern ICT systems. It was considered that it would be useful to have criteria with which CARICOM countries might use to assess the current state of their national legislation in this regard.

b) ICT policies for DRM

In the area of policies specific to ICTs, more than 80 per cent indicated that the existing national DRM plan did not explicitly address how ICT fits into DRM governance guidelines. Further, within sub-regional DRM agencies, approximately 65 per cent of respondents indicated that there was no internal ICT policy within their organisation which supported their DRM mandate.

It was noted in the expert group discussion that national ICT policies do not currently reflect support for DRM either. It was agreed that national ICT policies should be updated to reflect the need to support disaster offices in the event of an emergency. These policies should not only provide for the availability of a national government's ICT resources, but also those of non-governmental organizations, organizations in the private sector and resources available at a regional and national level. Participants felt that telecom operators, specifically, need to be brought into formalized agreements with regard to providing emergency support for disaster response and recovery operations.

From the survey responses, it can be seen that at the organisational level, operationally good structure, rules and guidelines seem to exist. This augurs well for the automation of processes and for the incorporation of ICT systems to enhance operational efficiency. It can be seen, however, that few agencies have extended these rules to speak to ICT usage at the policy level. In terms of next steps, this should be high priority for DRM agencies in the Caribbean.

At the inter-agency level, while some structures and guidelines do exist within the subregional DRM sector, these guidelines are either not universally known or complied with, even among agencies charged with aspects of the DRM mandate. Further, it can be seen that national guidelines generally have not been translated into directives for ICT use and into common protocols for information sharing among collaborator agencies.

Standardised frameworks and protocols will need to be established among subregional disaster agencies as well as collaborator organisations with regard to information formats and inter-operability. This will facilitate the reliable and productive exchange of data within national DRM eco-systems as well as across borders between CDEMA and other national DRM offices.

3. Human Resource Capacity

In examining the human resources capacity of DRM organizations, the survey sought to quantify the presence of skilled and trained ICT personnel, as well as the level of proficiency and expertise in the deployment and management of ICTs. The survey also looked at the level of comfort, proficiency and expertise of general staff in the use of ICTs to perform work related functions. In DRM, as with most sectors, the quality of labour has a significant bearing on the ability of an organization to effectively use new technologies, and to assimilate the new skills and methods of working needed to facilitate the management and sharing of information.

Ultimately, it is people and human resource capacity that determine the ability of an organisation to meet its strategic objectives. With regard to the organisational ability to leverage ICTs, assessing the human resource component is a key consideration to ensure that employees have the necessary knowledge, skills, experience and aptitude needed to leverage the use of ICTs to meet the organisation's goals.

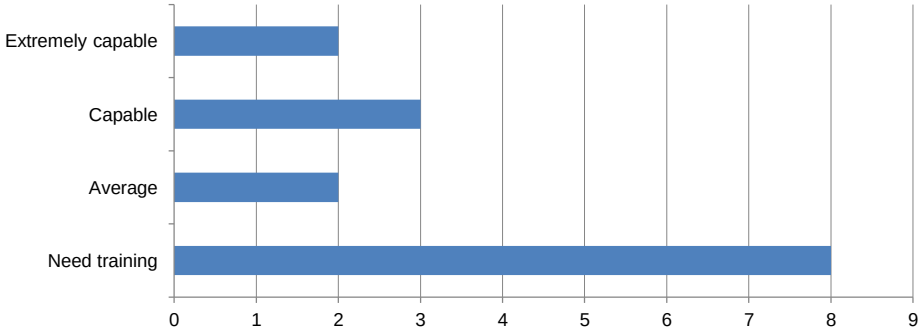
Given the critical role that people play in the success or failure of ICT implementation initiatives, gaps and challenges with respect to HR capacity must be determined. Identification of these gaps will help to assess the alignment of skills possessed versus skills required at each level of the organisation, and establish priorities for ICT training.

a) ICT capability of DRM staff

On review, the results of this aspect of the survey seem mixed. While approximately 60 per cent of national DRM executives responding indicated a belief that their staff is comfortable and proficient in the use of ICT tools to respond to disasters, as much as 54 per cent indicated that they did not believe that their organisation has the capability to cope with the inundation of information which takes place post-disaster.

Probing deeper, the survey asked respondents to rate the ICT capability to staff enaged in preparation activities. Over 50 per cent of respondents indicated their belief that additional training was required to boost capability (see Figure 5 below) while only 30 per cent were confident that availability and quality of internal technical ICT staff is not a constraint in advancing strategic rehabilitation initiatives.

FIGURE 5
PERCIEVED CURRENT ICT CAPABILITY OF DRM STAFF ENGAGED IN PREPARATION ACTIVITIES
(Frequency of answer)



Source: ECLAC survey on ICT for disaster risk management in the Caribbean

b) Presence and capability of ICT staff

When asked if the ability and quality of ICT staff is a constraint in advancing strategic rehabilitation initiatives, the majority of respondents were not sure of the answer. It may have been that this survey question was somewhat off-target; one respondent commented "Our current focus on the use of ICT in DRM is not targeted towards rehabilitation initiatives." Another said, "the constraint we experience has more to do with available funding for updated ICT tools."

While some respondents answered that ICT staff capability was not a constraint, more answered that they were. "There is much hardware and many ICT tools, but not sufficient specialised human capacity in the relevant offices." In many cases, it was indicated that ICT staff were not a part of the DRM organization, but that ICT support for these offices came from other departments in the government, or from the private sector. "We have no internal technical ICT personnel on staff," one respondent reported, "thus, we always have to seek outside aid. Certain minor jobs the staff can manoeuvre."

These responses seem inconsistent with the perceptions illustrated in Figure 1, earlier in this chapter, when DRM agencies reported a high regard for the ICT capabilities of other DRM agencies in the region.

c) Training needs for leadership and staff

For a different angle on the human resource capacity of DRM organization, the survey asked whether the senior management team had an understanding of how ICT fits into the disaster preparation activities of their country. Almost 50 per cent of respondents did not have confidence that DRM executives knew how or where ICT fits in this regard, and another 30 per cent were unsure. This indicates that education on ICT capabilities needs to be targeted at the very top of DRM organisations, so that leaders can make effective strategic decisions on how ICT projects can be implemented to contribute to the mission of protecting communities from disaster.

Overall, the data collected from Caribbean disaster management organisations indicates that improving the human resource capacity in respect of the use and leverage of ICTs to enhance their DRM mandate, should become a central issue going forward. The data indicated a certain lack of confidence by the leadership in the sector that organisations are sufficiently equipped with the ICT skill-sets needed to take the regional practice of comprehensive DRM to the next level. Thus, additional human resources capacity training in ICT is identified as critical requirement to ensure that strategic DRM initiatives are able to make appropriate use of ICT tools and infrastructure.

4. Psychographics

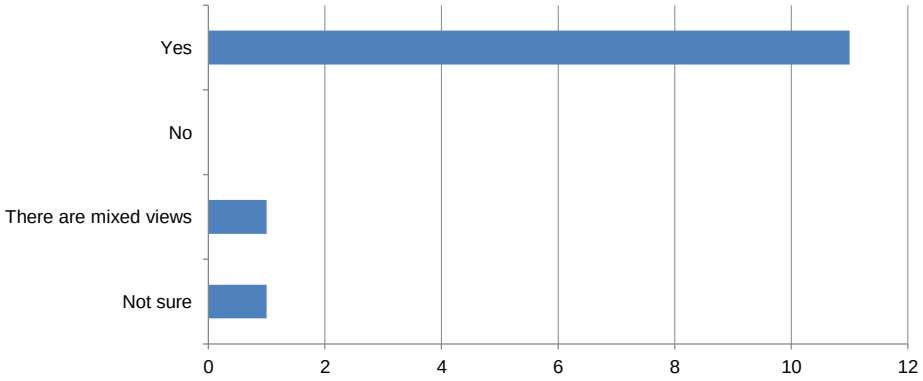
The term "psychographics" refers to an organisation's mindset and culture. In the context of innovation and the use of ICT tools, the psychographics portion of the survey investigates how organisations think about technology use and their willingness to adopt new, ICT enabled business models, working behaviours and innovations. It seeks to explore their ability to adapt to changing technology and businesses realities. This is the single greatest driving factor in an organisation's adoption and use of ICTs to achieve its goals.

a) Priorities

The data generated by the survey suggests that DRM agencies understand at a cognitive level that ICTs can and should play a greater role in bolstering their organisational efficiency, effectiveness, and ability to collaborate with other agencies. However, it is clear that more work needs to be done to help them translate that conviction into effective action in their organisations and within the region.

The vast majority of respondents confirmed that their executive team sees ICTs as a key enabler of effective response and immediate-post-disaster co-ordination (see Figure 6 below. A similar percentage said that their organisation has ICT advisers – either internal of external to the organization – to support organisational strategies. All but one respondent said "yes" when asked whether any ICT infrastructures or applications specifically for disaster risk management have been developed for or deployed by the organisation.

FIGURE 6
DOES YOUR EXECUTIVE TEAM SEE ICTS AS A KEY ENABLER OF EFFECTIVE RESPONSE AND IMMEDIATE-POST-DISASTER CO-ORDINATION?
(Frequency of answer)

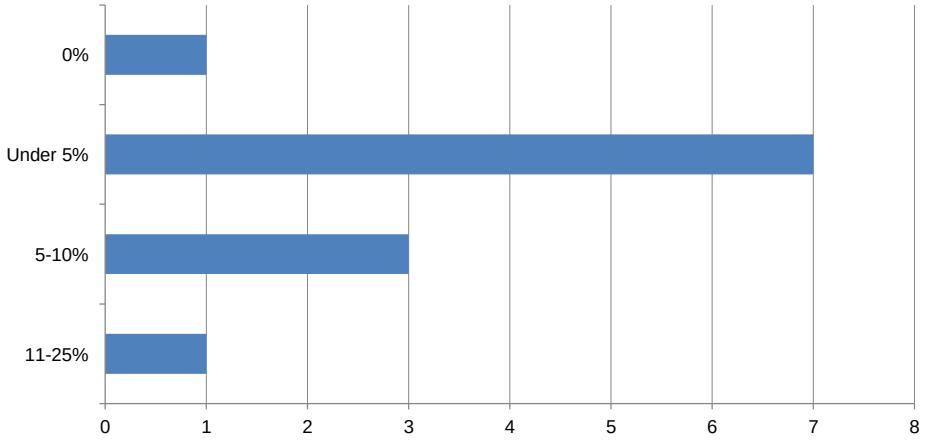


Source: ECLAC survey on ICT for disaster risk management in the Caribbean.

Contrastingly, over 40 per cent of respondents indicated that their organisation did *not* have champions for ICT at the executive levels within the organisation and only one responder expressed confidence that their organisation is aware of the latest ICT tools and applications available for disaster preparedness. Only four responders indicated that they had launched an innovative or ICT based service within the last 12 months while two thirds indicated that they were comfortable with their current DRM practices and methods.

When it comes to budgetary allocation, organisational commitment to ICT was not generally evident from responses. When asked about the percentage of annual budget spent on ICT infrastructure, applications, and training, over two thirds said that the allocation is less than five per cent. One respondent indicated zero percent. Only two respondents indicated that the current figure represented an increase over the previous year, and three indicated that it represented a decrease.

FIGURE 7
PERCENTAGE OF ANNUAL BUDGET SPENT ON ICT INFRASTRUCTURE, TOOLS AND TRAINING
(Frequency of answer)



Source: ECLAC survey on ICT for disaster risk management in the Caribbean.

b) Complacency

As an overall statement, the majority of respondents indicated that they were comfortable with their existing practices and methodologies for disaster management. This statement of comfort throws up a flag given the ground that must yet be covered among national DRM agencies to arrive at a place of optimal ICT usage for enhancing collaboration, educating populations and responding to events when they occur.

In the expert group meeting, it was suggested by respondents that elected officials of government can be caught in a traditional mindset. They frequently see disaster management as an issue of "biscuits, blankets, and plastic sheeting", and do not consider the ICT needs and ramifications of disaster management operations. Participants opined that, though governments are willing to talk about building disaster resilience into the development process, "this is where the discussion ends". It was felt that part of the reason for this is that governments in the region turn over fairly quickly, and often do not have time to implement their structural disaster resilience programs on the ground.

5. Infrastructure

The survey asked questions about the ICT infrastructure, platforms, services and applications currently in use by the DRM community in the Caribbean.

In order to leverage ICTs for DRM, staff within the organization must have access to the devices, connectivity and software that enable them to quickly access critical information, collaborate with peers and customers, and facilitate the performance of specialized technical work-related tasks. This includes mobile systems, which, in addition to providing communication facilities, also can be used to enable the collection and analysis of data in the field.

Beyond devices at the individual level, infrastructure must be in-place to facilitate organizational ICT administration as well as coordination with other agencies as appropriate. In the current technology environment, such infrastructure is not necessarily "on-premise", or hosted within the bounds of the agency, but can be operated through "cloud" services, which are off-site, commoditized application hosting platforms that have been optimized for efficiency, ease of management, and cost reduction.

a) On-line platforms

Disaster response agencies were asked about their usage of on-line platforms to interact with collaborator organisations. WebEOC was one tool that was being used by several Caribbean DRM agencies for event reporting and dispatching of responders. Another responder mentioned that they were using DEWETRA, a flooding and wildfire risk forecasting and monitoring platform that is afforded to Caribbean countries by the Italian government. DesInventar was also mentioned; it is a tool from UNISDR for the systemic collection, documentation, and analysis of data about losses caused by natural disasters. Other responders mentioned social media platforms like Facebook, Twitter, and Yahoo Groups. Video conferencing, DropBox, and email were also mentioned, as were efforts at developing collaboration systems in-house.

b) Challenges

When asked about the key challenges in terms of leveraging ICT infrastructures for DRM, particularly in respect of collaborating with stakeholders overwhelmingly respondents cited two issues:

- Limited human resources to develop, implement and manage ICT tools and applications
- Limited funding to expand implement and maintain newly available tools and applications

With regard to funding, discussions with DRM Executives revealed that infrastructure investment for ICT programs in DRM are frequently reliant on international donor agencies, and there was consensus that this represents a problem with regard to sustainability of the operations. One reported that, "the more [donor funding] you get, the more your budget gets cut. As a result, basic ICT equipment – computers in the disaster office – can be obsolete, and may take many years to replace."

Some expert group members made reference to the Caribbean Catastrophe Risk Insurance Facility (CCRIF), which covers certain post-disaster emergency costs for countries who are signatory to the agreement. Payments, however, are made only after a significant disaster has occurred. Some participants felt that the payoff from the insurance fund would be inadequate to cover much of the hypothetical reconstruction costs, and also that investing a smaller amount up front – in the areas of disaster preparedness and risk mitigation - could result in a significantly reduced cost of disaster-related damages within the region.

Beyond funding, other challenges also mentioned as significant were the lack of interoperability protocols and shared standards for information exchange, the existence of outdated and not regularly updated tools and applications, and the high cost of commercial off-the-shelf tools and applications. Lesser problems cited were poor dependability and reliability of internet connections, too many sources of data and information that are not integrated with each other, and lack of skills of those needing to access the information.

c) Systems for public communication

With regard to communicating with the public, the survey indicates that sub-regional organisations see their websites as the primary on-line mechanism for disseminating information to the public. Almost all respondent organisations indicated that they had a website and close to 70 per cent reported that these sites were updated at least once a week. Facebook was the next most popular internet-based offering with all but two respondents reporting that they had a Facebook presence for interacting with the public, and most reporting that their Facebook page was being regularly updated.

Other popular sources of electronic communications included email newsletters, YouTube, and Twitter. Blogs and Google+ were reported as less popular, each being used by less than 25 per cent of organisations responding.

d) ICTs for risk analysis and forecasting activities

For ICT use within DRM organisations, the most commonly reported tools used for risk analysis and forecasting activities were digital cameras, Geographic Information Systems (GIS), Global Positioning System (GPS), information and knowledge databases, and websites. Significant, though not as popular, was the reported use of text messaging and mobile applications, while the least used tool was remote sensing which was used by five of the countries who responded.

The survey results show that a range of infrastructure tools, applications and software is available to and in use by national DRM organisations. While there is a question about the sophistication of its use – particularly of GIS and remote sensing systems – ICT infrastructure, by and large, seems to be available to national DRM agencies.

Still, there were complaints expressed about the unavailability of adequate financing to keep these tools updated, the insufficient proficiency of staff to fully exploit the capability of the tools, as well as the lack of standardized protocols to facilitate ease of information exchange.

V. Conclusions and recommendations

This final chapter is focused on drawing conclusions and making recommendations based on the evidence developed in the empirical and theoretical studies. Further, it will attempt to identify ICT structures and strategies that are appropriate for DRM in the Caribbean.

A. Conclusions

1. ICTs hold the potential to greatly improve the efficiency and effectiveness of disaster risk management as practiced in the Caribbean

The implementation of ICTs for DRM in the Caribbean is uneven among countries and has been constrained by a number of limiting factors. This means that there is still quite a bit of room for growth in the sector, and tools that can overcome the problems of coordination, cost, and human resource limitations have the potential to elicit great improvements in the overall performance of DRM organisations.

ICT tools show great potential for DRM in the areas of communication, coordination, visualization, and risk analysis. Many tools, such as Google Maps and Twitter are available for free and do not require ICT specialists to support them. Web EOC is available at prices starting in the low tens of thousands of dollars, and has the ability to automate dispatching processes in hazard response situations. DEWETRA, a tool provided to Caribbean countries by the Italian government, can be used to predict and model flooding impacts before and during storm situations.

Together, these ICT tools provide new capabilities that have never before available to DRM agencies. In day-to-day, non disaster situations, these tools can be used in planning and developing risk reduction strategies. When a hazard strikes, they can help to manage the wave of information that arrives at a DRM office in immediate, post-impact instances, which survey respondents have identified as the most critical time for effective ICT performance. These tools can reduce the load on staff and free them to perform other duties.

Still, the implementation of ICTs for disaster risk management in the Caribbean is lagging, and this study has explored some of the reasons why.

2. Lack of human capacity is the single largest constraint on the implementation of ICT for DRM in the Caribbean

The survey identified human resource issues as a critical constraint on the ability of ICTs to empower DRM agencies in the pursuit of their mission. Case studies from Montserrat and Barbados also indicated that the execution of ICT projects was hampered by the lack of technological expertise. ICT staff are typically not integrated into disaster management offices, and staff are frequently under-equipped with the knowledge needed to support equipment and to make good decisions related to ICT matters.

However, it is clear from the empirical study's examination of psychographics that this limitation of human capacity in ICT is not unique to the front-line staff, but extends to the leadership of the organisations. With some exceptions, leaders of DRM organisations, largely through their own lack of understanding of ICT issues, have not been able to articulate a transformational vision for the use of ICT in disaster risk management. High levels of management frequently lack an understanding of what is possible using ICT, and so they are not able to direct their implementation effectively on the ground.

3. Individual countries in the Caribbean have seen a number of successful ICT projects, but integration is lacking at the regional level

Some of the successful projects uncovered in the process of preparing this study include:

- Implementation of GIS systems for scenario planning in Jamaica
- Use of Twitter as a public communications tool by ODPM in Trinidad & Tobago
- Improvements to the early warning systems in Montserrat that increased redundancy and unified the administration interface across multiple technologies

These projects are quite different in their purpose, implementation, and scope, but the common thread they share is one of innovation in the use of ICT tools to meet the goals of disaster risk management. However, this innovation is not yet evident on a regional level. Successful projects in countries are limited to those countries, and the technologies, lessons learned, and specialized skills have not been able to spread among the different islands in the region.

Smaller disaster offices, such as the one in Dominica (which has a staff of five), will never have the resources to implement the type of experimentation and ICT development that occurs in places like Jamaica and Trinidad & Tobago. There is a lack of regional mechanisms in place to ensure that the knowledge and tools built in the larger countries can be successfully integrated into the DRM practices of smaller countries.

B. Recommendations

1. Build greater connections with policy makers and other communities of practice

The research suggests that there exists a general culture of sharing within and amongst DRM collaborator agencies. However, there seems to be a gap in terms of knowledge sharing with other communities, particularly with the ICT community as well as policy makers. It was noted in the expert group meeting that DRM practitioners are frequently not included in national and economic policy discussions, particularly in the context of national ICT planning. This may contribute to the funding constraints which many respondents cited as impediments to doing more in DRM with ICTs.

In this regard, it would be useful for the DRM community to make a more concerted effort to reach out beyond their sector and build greater bridges to other professional communities. They should endeavour to connect their work with other areas of national and regional economic importance, such as tourism, agriculture, poverty eradication and sustainable development amongst others. A strong case can

be made that the economic impact of disasters has a direct bearing on the sustainability of other sectors important for the economic prosperity of Caribbean countries. This can establish a commonly shared perception of urgency and justification for greater incorporation of comprehensive disaster management approaches into national social and economic planning processes and funding priorities.

Government officials in national leadership should be afforded more opportunities to become aware of the best practices for incorporation of ICTs within the DRM framework, and learn about the successes which agencies have had in this regard around the world. This greater awareness and exposure, both at the agency level as well as at the government level, may help to move the discourse on ICT in DRM toward a culture shift that results in greater resource allocation, capacity building, and ICT-enabled implementation.

Outreach from DRM agencies should extend to the private sector as well. It was noted that CDEMA is currently examining public-private partnerships, particularly the roles of corporate entities and telecom providers such as Digicel and Lime, to help formulate a way forward in strengthening ICT infrastructure for increased disaster resilience. As one representative of a disaster office stated, "Most ICT platforms don't have a disaster risk reduction strategy and if the national ICT structures were damaged that could be a disaster in itself."

2. Modernise infrastructure for DRM

There is a need to increase the amount of ICT infrastructure available to support hydrology and meteorology information gathering, hazard and vulnerability assessments, early warning alerting, quick response capability, and the coordination of rehabilitation activities both nationally and with international partners.

Mobile devices (tablets and smart phones) for field workers, integrated GIS mapping tools for in-house professionals, disaster management databases and crisis management software should be among the standard tools available in every national DRM agency. The feedback from the survey suggests that while some DRM offices are equipped with these tools, many others do not have their full complement.

The lack of access to modern and up-to-date ICT infrastructure can severely hamper the effectiveness, timeliness and capability of a disaster management authority to competently respond to the occurrence of a national hazard. In the case of the Caribbean, disasters have ramifications beyond damage to private property and individual livelihoods; they can severely impact national economies and country development agendas.

Nevertheless, ICT systems should not be imposed on a national DRM agency without adequate assessment needs and organisational readiness. While a consideration of potential technological solutions may prove useful, an assessment should also consider the disposition of the key actors toward ICTs, the state of human and institutional capacity, the availability of relevant and accessible data, the quality of current infrastructure and the maturity of governance arrangements. These considerations must be evaluated before equipment is bought. It is the outcome of such evaluation which should determine what actual information systems can be implemented to obtain optimal and sustainable results.

In this regard, this study recommends that each DRM agency in the region undertake to implement their own e-readiness assessment, at the organizational level, that can form the basis for the development of their strategy for ICT infrastructure upgrading.

3. Consider a regional e-strategy for DRM

While each DRM office has primary responsibility for its own national disaster risk reduction agenda, the existence of CDEMA is an acknowledgement that intra-regional co-operation, as well as support from international agencies, is vital to providing the environment and incentives as well as in developing the knowledge, capacities and motivation needed to build a resilient subregional DRM sector. No single nation of the Caribbean will be able to achieve its disaster management goals acting alone.

With regard to ICT infrastructural development, it is likely not feasible for each island nation of the region to deploy all of the disaster resilient internet and communication infrastructure – such as tier I

data centres, mirrored internet root servers, internet exchange points and portable cellular towers – that may be necessary to provide a high level of resilience in post-disaster national business continuity.

There is highly extensive mobile access in the Caribbean, yet there are no deployed domestic mobile application platforms specifically geared to serve the region's DRM needs. National ICT plans, as well as CARICOM-wide regional initiatives should be implemented to ensure that:

1. Adequate ICT infrastructure (particularly broadband) is available throughout all regional territories
2. Telecommunication infrastructure is accessible by practitioners in the DRM sector, as well as communities assessed as most vulnerable
3. The infrastructure itself, be it publicly or privately owned, is designed with DRM compliance and resilience
4. There is a broad base of support for the creation and deployment of purpose-built databases, intranets, and applications that are of direct benefit to vulnerable communities, and the wider DRM eco-system
5. Relevant, locally generated information, content and research on the regional sector is created and made available to DRM practitioners

Additionally, it should be noted that there are some classes of coordination applications which can be useful to DRM practitioners only if operated at a regional level. This includes applications that support information sharing across the region by facilitation and participation of numerous disaster management offices. For example, the concept of a National Asset Register was brought up by a participant in the survey, as well as a member of the expert group. This application would enable the listing and sharing of available resources among the various DRM offices. Countries would list assets that they have available for share or sale – for example, an excess stock of corrugated metal – and other countries would be able to call upon these assets in the course of their disaster management cycle. This type of application would be quite useful to the DRM community, but could only be facilitated through cooperation at a regional level.

Finally, as one respondent to the survey noted, "A regional network of trained specialists would help us as a region keep up with the new technologies and also provide a platform through which we all could share our experiences and collectively decide on a best way forward as a region rather than individual countries as we combat the common threat of disaster."

4. Improve ICT governance and interoperability guidelines

Leveraging existing regional cooperation arrangements between CDEMA and national DRM agencies, a strategy should be determined that articulates arrangements for the sharing of access to critical ICT infrastructure on an on-going basis, as well as arrangements for shifting network operations, should the ICT infrastructure available to one (or more) national agencies be compromised immediately post-disaster.

For the development of a subregional corporation framework on ICT for DRM, care should be taken to avoid the duplication of commitments already in place to regional organizations, such as the ACS, the CDB and CDEMA, who each have a DRM strategy or plan in force. Great effort should be targeted toward the achievement of a single comprehensive, unambiguous framework for synergising national ICT operations, so as to provide for greater efficiency, reduced latency and improved subregional network resilience. Consideration should be given to the establishment of a streamlined governance system, through, for example, an enhanced CDEMA capacity, to provide the region with a more effective collaborative architecture for ICT-enabled comprehensive disaster management.

At the inter-agency and operational levels, national DRM agencies should seek to clarify technology and data standards that they will adopt for infrastructure sharing and data exchange. A number of survey respondents cited a "lack of standardised formats", "too many sources of data that are not integrated with each other" and a "lack of interoperability protocols and shared standards" as key

challenges in using ICTs to coordinate with collaborator agencies. Agencies should agree and adopt common standards on each of the different information formats (e.g. text, audio, video, web, database, etc) and ensure that every new purchase or deployment can output and process to these standards.

Such arrangements can improve data processing efficiency, ensure that successful pilot projects are scaleable, and can significantly enhance the productivity of staff engaged in DRM activities. In this regard, ICT policies should be developed and enforced both at the organisational and inter-agency level.

5. Develop programs of ICT human capacity development as a matter of priority

The twin spaces of Information and Communications Technologies and Disaster Risk Management – both relatively new fields of endeavour - have in the Caribbean traditionally developed quite separately. As the results of the survey show, there are a many senior practitioners in the DRM sector with no background in ICT and who are not particularly aware of the role that information and communication technologies can play in advancing the sector. At the same time, practitioners in the ICT space in the region tend to have very little understanding of the discipline and profession of comprehensive disaster management and are not as yet skilled in being able to apply the tools, concepts and approaches of ICT to be effective in a DRM environment.

Thus, a major component of any regional e-DRM strategy will need the creation of on-going structures for training, capacity development, information sharing and cross-pollination of strategic ICT and DRM personnel. This will serve to build a cadre of managers, administrators, leaders and practitioners within both sectors who fully appreciate the benefit that ICTs bring to the practice of disaster risk reduction and who also recognize the consequences of not incorporating "new" information technologies into the core processes of the disaster risk management function. This recommendation is probably the most important in light of the high level of vulnerability of the Caribbean with regard to natural hazard events.

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Annex

Survey: ICT for disaster risk management in the Caribbean

Background

The economic cost of natural and man-made disasters worldwide amounted to US$ 370 billion in 2011, a huge increase over the previous year. The United Nations reported that in 2010 alone, 373 earthquakes, floods, cyclones, volcanic eruptions, and droughts occurred, which affected 208 million people around the world, killing nearly 300,000, and costing US $110 billion in losses. Earthquakes in Haiti (12 January), Chile (27 February), and China (13 April), flooding in Pakistan (July to September), and heat-waves in Russia (July to September) were the five most devastating natural catastrophes in 2010, which claimed 280,000 lives and US$52 billion worth of losses.

When disasters have hit the Caribbean, they have had devastating results. Hurricane Gilbert is estimated to have cost Jamaica $4-6 billion, while the Eastern Caribbean Central Bank reports that in 1995, because of Hurricane Luis, Antigua and Barbuda saw losses of 4,000 to 7,000 jobs, an estimated 15-25% of the workforce.

Anguilla too was hit by Hurricane Luis in 1995 and saw real output decline by 4.2 per cent. Agricultural output often also suffers. Dominica, for example, saw banana production fall by 22.8% in 1995 because of an almost total destruction of the crop due to tropical storm Iris and Hurricanes Luis and Marilyn. More recent disasters such as Hurricane Ivan 2004, the 2010 earthquake in Haiti, the 2010 volcanic eruption in Montserrat, and Hurricane Sandy in 2012, just to name a few, have taken an extensive toll on the subregion. Emergency occurrences cannot be eliminated, but they can be better managed. The successful management of emergency situations requires proper planning, guided response, and well-coordinated efforts across the emergency management life cycle.

Information and communication technologies (ICTs) have made incredible leaps in utility, applications, and capacity. The revolutionary potential of ICTs lies in their ability to instantaneously connect vast networks of individuals and organizations across great geographic distances, and to facilitate fast flows of information, capital, ideas, people and products. They have become essential tools for cooperation and collaboration, making ICTs an invaluable tool in DRM.

Purpose of the survey

This survey is part of a study being conducted by ECLAC subregional headquarters for the Caribbean. It seeks to ascertain the current situation of ICT use in disaster risk management in the subregion. The intention is to understand the gaps and challenges which exist, with a view to enabling appropriate recommendations with regard to future developments in ICT infrastructure and tools for DRM in the Region. The key issues being assessed are:

- Which ICT's are being used for DRM in the Caribbean
- How successful they are in enhancing DRM preparedness, mitigation, response and rehabilitation
- What are the gaps and challenges
- How these gaps and challenges should be addressed.

Completing the questionnaire

1. All information is purely gathered for the purpose of analysis and any personal information will be treated as confidential.

2. This is an online questionnaire. You therefore do not have to print, scan, email or fax the completed questionnaire. Just click on the submit button when you have completed the survey.
3. Should you require assistance in completing the questionnaire, please contact ckmc-pos@eclac.org and we will guide you through the questions via telephone.
4. Deadline for completing the survey is: 16 August 2013.

Thank you for participating in the Survey!

Section 1: About your organization

A. Respondent information

Respondent Name (optional):

In the case of multiple respondents, please provide the name of each respondent

_____

Position/Job Title (optional):

In the case of multiple respondents, please provide the job title of each respondent

_____

Email (optional):

_____

Telephone number (optional):

_____

B. Organization information

Name of organization:

_____

Web address (URL) of organization:

_____

Section 2: Operating environment

The term "**disaster**" can be defined as a social crisis situation; an event, usually unexpected and unanticipated, which can cause human suffering and has the potential to significantly and possibly irrevocably damage the reputation and earning power of a society, organization, country or individual.

1. What types of disasters does your agency/organization manage? *Please, select all that apply*

- ☐ Climate change
- ☐ Drought
- ☐ Earthquakes
- ☐ Fires
- ☐ Flooding
- ☐ Hurricanes and tropical storms

- Landslides
- Tornadoes
- Tsunamis and coastal hazards
- Other Hazards - biological
- Other Hazards - industrial
- Other Hazards - terrorism
- Other? _____

2. How does your organisation keep up with the latest innovations and developments in the field of Disaster Risk Management (DRM)?

	N/A	At least once daily	At least once weekly	At least once monthly	At least once yearly
Face to face training					
Online training					
Conferences/workshops					
Attending trade shows					
E-mail exchange with fellow professionals					
Online networking					
Social media					
Newspapers/journals/other print materials					
Library research					
Internal research projects					

3. Do you have any ICT champions at the *senior management* or *executive level* in your organization?

- Yes
- No

4. Do you have an internal ICT policy in your organization that supports your DRM mission?

- Yes
- No

Questions 5-9 refer to the customers of disaster offices:

5. What key customer groups do you serve? *Please select all that apply*

- General population
- Private sector/industry

□ State sector/government

□ Other? *(please specify)* _____

6. Does your organization utilize the internet to share information with its key customer groups? How frequently do you update any internet properties that you have? Please indicate all that apply. If you do not have a presence in any of the categories below, please tick "N/A"

	N/A	Use but don't measure	At least once daily	At least once weekly	At least once monthly	Less than once a month	Ass needed
Email newsletter	□	□	□	□	□	□	□
Website	□	□	□	□	□	□	□
Blog	□	□	□	□	□	□	□
Facebook	□	□	□	□	□	□	□
Twitter	□	□	□	□	□	□	□
Google+	□	□	□	□	□	□	□
YouTube	□	□	□	□	□	□	□

6.1. If 'Other' was selected, please specify and provide the respective ranking.

_____
_____
_____

7. Please indicate the number of persons among your customer groups, reached by the following forms of online communications.

	N/A (Don't use)	Use but don't measure	<100	100-500	501-1000	1001-5000	>5000
Email newsletter (no. of subscribers)	□	□	□	□	□	□	□
Website (no. of hits per month)	□	□	□	□	□	□	□
Blog (no. of hits per month)	□	□	□	□	□	□	□
Facebook (no. of members)	□	□	□	□	□	□	□

Twitter (no. of followers)	□	□	□	□	□	□	□
Google+ (no. of members)	□	□	□	□	□	□	□
YouTube (no. of monthly views)	□	□	□	□	□	□	□

7.1 If 'Other' was selected, please specify and provide the respective ranking.

_____
_____
_____

8. Do you think that your internet communication methods have increased your organisation's reach and / or effectiveness? Please select only one option

□ Yes

□ Not sure - We don't measure or report

□ No

□ We do not use the Internet to reach customers

8.1 *Please explain:*

_____
_____
_____

9. Are there any other organisations in your country that provide disaster related services?

□ Yes

□ No

□ Not sure

9.1 If "Yes", please indicate who they are.

_____
_____
_____

Questions 10-12 refer to collaborator/disaster partners of disaster offices:

10. With whom do you collaborate in the delivery of your DRM services? *Please select all that apply.*

□ Universities

□ Red Cross

□ International aid organization

- Telecommunications companies
- Environmental management authorities
- City corporations
- Private contractors
- Hospitals and medical companies
- Army
- Coast Guard
- Other regional (Caribbean) disaster management agencies
- Other? *(please specify)* _____

11. Please rate the ICT capability of the persons with whom you collaborate to deliver DRM services.

	Not sure (0)	Not capable (1)	Adequate (2)	Above average (3)	Expert (4)
Universities					
Red Cross					
International aid organization					
Telecommunications companies					
Environmental management authorities					
City corporations					
Private contractors					
Hospitals and medical companies					
Army					
Coast Guard					
Other regional (Caribbean) disaster management agencies					

11.1 If 'Other' was given in question 10, please provide the respective ranking.
_____
_____
_____

12. Do you use any ICT tools to assist or facilitate communication with your collaborators?

	N/A	Rarely (at least once a quarter)	Sometimes (at least once a month)	Frequently (at least once a week)	Very frequently (at least once a day)
Face to face	☐	☐	☐	☐	☐
Traditional mail/post	☐	☐	☐	☐	☐
Telephone	☐	☐	☐	☐	☐
Mobile	☐	☐	☐	☐	☐
E-mail	☐	☐	☐	☐	☐
Fax	☐	☐	☐	☐	☐
Social media	☐	☐	☐	☐	☐

12.1 If 'Other', please specify and provide the respective ranking.

_____
_____
_____

13. Does your country have an official and current National Disaster Preparedness/Response/Management Plan?

☐ Yes

☐ No

14. Does your National Disaster Plan or Policy clearly explain the role of ICT in DRM?

☐ Yes

☐ No

☐ Not sure

☐ Not applicable

15. What is the level of compliance of your organization and collaborators with existing national DRM plans and policies?

☐ Not sure

☐ Compliance is not measured

☐ Mostly out of compliance

☐ Aware but not fully complaint

☐ Full compliance

16. How many officers are in your organization in the following categories? Please select the appropriate range of number of staff for each level of staff.

	0-5	6-10	11-15	16-20	>20
Executive	☐	☐	☐	☐	☐
Professional	☐	☐	☐	☐	☐
Field	☐	☐	☐	☐	☐

17. What is highest level of education and special training that your staff members have completed at your organization?

☐ Diploma/Certificate

☐ Undergraduate degree

☐ Postgraduate degree

☐ Doctoral degree

☐ Other

17.1 If 'Other' was selected, please specify

_____

18. What percentage of your annual budget is spent on ICT infrastructure / tools / applications?

☐ 0%

☐ Under 5%

☐ 5-10%

☐ 11-25%

☐ 25- 40%

☐ Over 40%

18.1 In comparison with the previous fiscal year, this represents a...

☐ Increase

☐ Same

☐ Decrease

Section 3: Preparation

Preparedness - The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions. It is based on a sound analysis of disaster risks and good linkages with early warning systems.

Recent studies by the World Bank, the Asian Development Bank and the US Government have shown that every dollar invested in disaster preparedness not only saves lives, but can also save between US$4 and US$7 in humanitarian relief and reconstruction costs after a disaster occurs.

19. What preparatory activities is your organization involved in? Please select all that apply

- Analysis of disaster risks
- Establishing early warning systems
- Calculating the probability that a natural hazard will occur
- Identifying vulnerability factors in society
- Drawing up damage scenarios
- Evaluating measures for rapid reconstruction
- Evaluating impact via damage and loss assessments
- Collaboration with other agencies involved in emergency planning
- Other (please specify) _____

20. Which ICT tools or software applications do you use in your risk analysis or forecasting activities? Please select all that apply

- We don't use ICT tools
- Commercial off-the-shelf software
- Digital cameras
- Free or open source software
- Geographic Information Systems (GIS)
- Global Positioning System (GPS)
- Information & knowledge databases
- Mass text-messaging-services (MMS)
- Mobile applications
- Remote sensors
- Social media tools
- Satellite imaging
- Websites
- Other (please specify) _____

21. How would you rate the ICT capability of your staff engaged in preparation activities?

- Extremely capable
- Capable
- Average
- Need training
- Not capable

22. Does your Senior Management / Executive Staff have a strategic understanding of how ICT fits into the disaster preparation activities for your country?

- Yes
- No
- Not sure

23. What type of information does your organization gather to do risk analysis and forecasting? Please select all that apply

- Assessments of disaster prone areas
- Geospatial information
- Geologic and hydro-meteorological information
- Emergency personnel and volunteers
- Information on vulnerable and at risk populations
- Digital photos
- Digital mapping
- Emergency equipment and medical supplies
- Hazard and vulnerability maps
- Evacuation routes and locations of shelters, clean water, food
- Other (please specify) _____

24. What ICTs do you use to gather the information indicated above? Select an answer for each tool

24.1 Mobile phones

	Not applicable	No	Yes
Voice			
SMS (text messaging)			
E-mail			

24.2 Computers

	Not applicable	No	Yes
Laptop			
Tablet computer			
Desktop computer			

24.3 Applications and software

If "YES", please select the appropriate category, namely online app, customer/special purpose DRM app or home grown DRM app, where applicable.

Terminology Definitions:

- Online app' refers to and free/paid online software/programs that are utilized by your business to aid in DRM service output. (eg Google Earth/ Google Sketchup/ Google drive)
- 'Custom/Special Purpose DRM app' refers to custom/specialized software that was developed to address the specific DRM services that of your business provides.(e.g. Ushanti Database)
- 'Home grown DRM app' refers to specialized software that was internally developed at your business.

	Not applicable	No	Yes	Online app	Custom/Special DRM app	Home grown DRM app
MS Office (or similar)	☐	☐	☐	☐	☐	☐
Document Management	☐	☐	☐	☐	☐	☐
GIS/Mapping	☐	☐	☐	☐	☐	☐
Expert systems	☐	☐	☐	☐	☐	☐
Database systems	☐	☐	☐	☐	☐	☐
E-mail	☐	☐	☐	☐	☐	☐
VOIP (Skype etc)	☐	☐	☐	☐	☐	☐

24.4 Please specify any other tools not given above

_____

_____

_____

25. How does your Agency collaborate with other institutions on ICT tools and applications? Please rate each of methods where 0 = N/A, 1 = Not important/don't collaborate, 2 = Not very important, 3 = Important, 4 = Very important

	0	1	2	3	4
Developing and implementing distributed tools and applications	☐	☐	☐	☐	☐
Developing and standardising protocols for data gathering, analysis and representation	☐	☐	☐	☐	☐
Collaborating and sharing best practices and approaches	☐	☐	☐	☐	☐
Sharing access to tools and applications, such as databases	☐	☐	☐	☐	☐

25.1 Other? Please specify and rate accordingly

_____
_____
_____

26. Is your organization aware of the latest ICT tools and applications that are available for disaster preparedness?

- Yes
- No
- Not sure

26.1 If "Yes" please explain. If "No" please go to question 27

_____
_____
_____

27. What challenges does your organization experience using ICT tools to collaborate with stakeholders?
Please select all that apply.

- Poor dependability and reliability of Internet connections
- Outdated and not regularly updated tools and applications
- Lack of interoperability protocols and shared standards for information exchange
- High cost of commercial off-the-shelf tools and applications
- Limited human resources to develop, implement and manage tools and applications
- Limited funding to expand, implement and maintain newly available tools and applications
- Errors in data entry
- Too many sources of data and information that are not integrated with each other
- Lack of skills of those needing to access information
- Not sure
- Other? (please specify) _____

28. Have any ICT infrastructures or applications specifically for disaster risk management, been developed for or been deployed by your agency?

ICT (e.g.1): Mass text messaging service that serves as an early warning system
ICT (e.g.2): Mobile cellular towers to facilitate quick re-establishment of communication in cases of disasters such as floods or hurricanes

- Yes
- No

28.1 If "Yes" please explain. If "No" please go to question 29

_____
_____
_____

29. Please comment on the effectiveness and challenges of ICT infrastructures specifically developed for your Agency.

_____
_____
_____

30. Is there a clear metric that governs when an early warning message is triggered?

- Yes
- No

30.1 If "Yes" please explain

If "No" please go to question 31

_____
_____
_____

Section 4: Mitigation.

Mitigation refers to the lessening or limitation of the adverse impacts of hazards and related disasters. It encompasses engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness.

Measures to completely avoid the adverse impacts of hazards and related disasters (disaster prevention) include dams or embankments that eliminate flood risks and land-use regulations that do not permit any settlement in high risk zones. Very often, however, this complete avoidance of losses is not feasible and the task transforms to that of mitigation. Partly for this reason, the terms prevention and mitigation are sometimes used interchangeably in casual use.

31. What aspect of mitigation is your organization involved with? Please select all that apply.

- Public awareness
- Environmental policy
- Land use policy
- Building codes/standards
- Vulnerability assessments
- Community capacity building
- Other? (please specify) _____

32. What monitoring mechanisms do you have in place to ensure adherence to mitigation guidelines, policies, or legislation?

- We do not have guidelines
- We have guidelines but no monitoring mechanisms
- Policies/guidelines are "draft" and agencies are not bound to follow them
- Legislation is passed but more than 15 years old (not current)
- Policy/legislation is current and monitoring mechanisms are in place

32.1 Please provide any comments on your choice above

_____
_____
_____

33. What ICT tools do you employ to interact with your customers and collaborators with regard to disaster mitigation measures? Please include more than one tool per box as necessary

Public awareness
_____
Environmental policy
_____
Land use policy
_____
Building codes/standards
_____
Vulnerability assessments
_____
Community capacity building
_____
Other (Please specify)
_____

34. Do you have ICT advisers (either internal of external to your organization) to support your mitigation strategies?

- Yes (External)
- Yes (Internal)
- Yes (Both internal and external)
- Not sure
- No

35. Have you launched any innovative or ICT based services or initiatives with respect to mitigation in the last 12 months?

- Yes
- No

35.1 If "Yes" please specify

If "No" please go to question 36

_____
_____
_____

Section 5: Response

Disaster response can be defined as the provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

36. Are there pre-designed rules to govern how information received by your organization during or just after a disaster is to be utilized?

- Yes
- No
- Not sure

36.1 If "Yes" please specify

If "No" please go to question 37

_____
_____
_____

37. Are there any pre-defined budgetary/ business arrangements in place with collaborator agencies or with the private sector, which can be activated during disaster response?

- Yes
- No
- Not sure

37.1 If "Yes" please specify

If "No" please go to question 38

_____
_____
_____

38. Does your executive team see ICTs as a key enabler of effective response and immediate-post-disaster co-ordination?

- Yes
- There are mixed views
- No
- Not sure

39. Is your staff comfortable with and proficient in using ICT tools to respond to disasters?

- Yes
- No

40. Does your organisation have the ability to cope with the inundation of information that takes place post-disaster?

- Yes
- No

40.1 Please comment on your choice above

_____
_____
_____

41. What immediate information does your organization gather during or post disaster? Please indicate how this information is gathered as well as any ICT tools employed.

How is the information gathered?

Emergency equipment _____
(location, availability) _____
_____

Emergency medical supplies _____
_____
_____

Deaths/Injuries _____

_____

_____

Volunteers (location, skill-sets) _____

_____

_____

Shelter status _____

_____

_____

Meteorological _____

_____

_____

Property damage _____

_____

_____

Other (Please specify) _____

_____

_____

ICT Tools Employed?

Emergency equipment _____

(location, availability) _____

_____

Emergency medical supplies _____

_____

_____

Deaths/Injuries _____

_____

_____

Volunteers (location, skill-sets) _____
_____
_____

Shelter status _____
_____
_____

Meteorological _____
_____
_____

Property damage _____
_____
_____

Other (Please specify) _____
_____
_____

Section 6: Recovery/ Rehabilitation

Disaster recovery or rehabilitation can be defined as the restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors. Recovery programmes, coupled with the heightened public awareness and engagement after a disaster, afford a valuable opportunity to develop and implement DRR measures and to apply the 'build back better' principle

42. Please comment on the challenges of the collaboration with other institutions with regard to efforts at disaster rehabilitation, in those areas in which your organization provides recovery services.
Please select all that apply and provide a relevant comment relating to challenges experienced Recovery/Rehabilitation Activity

Damage assessment ☐
Providing relief capacity ☐
Restoration of damaged property ☐
Funding/Insurance ☐
Other (please specify) ☐

Challenge coordinating with recovery partners

Damage assessment _____
_____

Providing relief capacity _____
_____

Restoration of damaged property _____
_____

Funding/Insurance _____
_____

Other (please specify) _____
_____

43. What is the level of compliance with national recovery/ rehabilitation guidelines currently in place on the part of state agencies and the private sector?

- Complete lack of compliance/awareness
- General lack of compliance
- Compliance is based on the discretion of each agency
- Agencies are aware but only comply when compelled
- Close to full compliance

44. How does your agency use information from previous hazards to inform rehabilitation strategies?

_____
_____
_____

45. Is the availability and quality of internal technical ICT staff a constraint in advancing strategic rehabilitation initiatives?

- Yes
- No
- Not sure

45.1 Please comment on your choice above

_____
_____
_____

46. What, if any, online or web based information exchange platforms exist between your organisation and its national / international collaborators?

_____
_____
_____

47. Do the ICT applications of different agencies involved in DRM share information?

- Yes
- No

48. Does your organization see a Regionally integrated information system (an information system that fully accessible by all member countries and to which all countries can upload and query data) as a key enabler of enhancing future DRM effectiveness?

- Yes
- No
- Not sure

48.1 If "Yes" please specify

If "No" please go to question

_____
_____
_____

49. Are you comfortable with your existing practices and methodologies for DRM?

- Yes
- No

49.1 Please comment on your choice above

_____
_____
_____

50. Do you think that a regional network of DRM specialists trained in the strategic relevance of ICT would be beneficial?

- Yes
- No
- Not sure

50.1 Please comment on your choice above

_____
_____
_____

51. Please provide any final comments and suggestions

_____
_____
_____

Thank you for your time and consideration.

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16. Caribbean Millennium Development Goals Report 2010, LC/CAR/L.371, 2011.
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