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ICT FOR DISASTER RISK REDUCTION

UNITED NATIONS **APCICT-ESCAP**

ICT FOR DISASTER RISK REDUCTION

Asian and Pacific Training Centre for Information
and Communication Technology for Development (APCICT)

ICTD Case Study 2

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ICT for Disaster Risk Reduction

United Nations Asian and Pacific Training Centre for Information
and Communication Technology for Development (UN-APCICT/ESCAP)

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Acronyms

AADMER	ASEAN Agreement on Disaster Management and Emergency Response
Academy	Academy of ICT Essentials for Government Leaders
AHP	Analytic Hierarchy Process
APCICT	Asian and Pacific Training Centre for Information and Communication Technology for Development
ARC	Alert Retrieval Cache
AREA	Addressable Satellite Radios for Emergency Alerting
ASEAN	Association of Southeast Asian Nations
AVA	APCICT Virtual Academy
BAKORNAS PB	National Coordinating Agency for Disaster Management, Indonesia
BMD	Bangladesh Meteorological Department
BNPB	National Disaster Management Agency, Indonesia
BRR	Aceh-Nias Rehabilitation and Reconstruction Agency
BTCL	Bangladesh Telecommunications Company Ltd.
BTRC	Bangladesh Telecom Regulatory Commission
CAP	Common Alerting Protocol
CB	Cell Broadcasting
CBDRM	Community-based Disaster Risk Management
CBO	Community-based Organization
CDMP	Bangladesh Comprehensive Disaster Management Programme
CFP	Community Focal Point
CNO	Centre for National Operation, Sri Lanka
CO	Country Office, UNDP
CPP	Cyclone Preparedness Programme, Bangladesh
CRED	Centre for Research on Epidemiology of Disasters
CTEC	Community Tsunami Early Warning Centre
DAD	Development Assistance Database
DDPM	Department of Disaster Prevention and Mitigation, Thailand
DEM	Digital Elevation Model
DFID	UK Government's Department for International Development
DMB	Disaster Management Bureau, Bangladesh
DMC	Disaster Management Centre, Sri Lanka
DMIC	Disaster Management Information Centre, Bangladesh
DRR	Directorate of Relief and Rehabilitation, Bangladesh
DRR	Disaster Risk Reduction
ENSO	El Niño-Southern Oscillation
EOC	Emergency Operation Centre
ESCAP	Economic and Social Commission for Asia and the Pacific
ETC	Emergency Telecommunication Cluster
EWS	Early Warning Systems
FOSS	Free and Open Source Software
GDACS	Global Disaster Alert and Coordination System
GDP	Gross Domestic Product
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GIS	Geographic Information Systems
GLIDE	Global Identifier Number
GoB	Government of Bangladesh
GoTN	Government of Tamil Nadu, India
GPS	Global Positioning System
GSMB	Geological Survey and Mines Bureau, Sri Lanka
HFA	Framework for Action
HIH	Hazard Information Hub, Sri Lanka
IARU	International Amateur Radio Union
ICRRP	Inventory of Community Risk Reduction Programme, Bangladesh
ICT	Information and Communication Technology
ICTD	Information and Communication Technology for Development
IDRN	India Disaster Resource Network
IFRC	International Federation of Red Cross and Red Crescent Societies
ITU	International Telecommunication Union
LAN	Local Area Network
M/DM&HR	Ministry responsible for Disaster Management and Human Rights, Sri Lanka
MDG	Millennium Development Goal
MoFDM	Ministry of Food and Disaster Management, Bangladesh
MoU	Memorandum of Understanding
MPND	Ministry of Planning and National Development, Maldives
NCDM	National Council for Disaster Management, Sri Lanka
NCDR	National Committee for Disaster Reduction, China
NDMC	National Disaster Management Centre, Maldives
NEOC	National Emergency Operation Centre
NGO	Non-governmental Organization
NHNL	New Home New Life, Afghanistan
NIC	National Informatics Centre, India
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PGIS	Participatory Geographic Information Systems
RAD	Remote Alarm Device
RAND	Recovery Aceh-Nias Database
RP	Regional Programme on Capacity Building for Sustainable Recovery and Risk Reduction, UNDP

SAR	Synthetic Aperture Radar
SEA-EAT	South-East Asia Earthquake and Tsunami, Blog
SMS	Short Message Service
SOD	Standing Order on Disasters, Bangladesh
TSF	Télécoms Sans Frontières
UN	United Nations
UNDP	United Nations Development Programme
UN/ISDR	United Nations International Strategy for Disaster Reduction
UNOSAT	United Nations Operational Satellite Applications Programme
Virtual OSOCC	Virtual On-Site Operations Coordination Centre
VIT	Vellore Institute of Technology, India
VSAT	Very Small Aperture Transmission
XML	eXtensible Markup Language
WC	World Changing
WFP	World Food Programme
WHO	World Health Organization
WSIS	World Summit on the Information Society
WWH	World Wide Help

Foreword

Rapid advances in information and communication technology (ICT) have begun to touch - and frequently transform - the lives of people and communities in ways that were virtually inconceivable just a few decades ago. In urban centres, ICT-enabled services are opening up new windows of skilled jobs and opportunity for underserved youth. Farmers are learning about modern agricultural techniques and buying quality inputs online to increase their productivity. Doctors are diagnosing common ailments and recommending treatment to patients in far-away villages via telemedicine networks, while fishermen are accessing advance warnings of impending bad weather conditions before venturing into the sea via mobile phones, thus saving lives. The examples are indeed plentiful.

While the linkages between ICT and development are strong and well acknowledged, there are sharp disparities in access to ICT and its benefits between the developed and developing world which reflects a major digital divide. For instance, according to the International Telecommunication Union, the percentage of internet users is much higher in developed countries than in developing countries where four out of five persons are still not able to avail of the benefits of being online. Such disparities also prevail in the Asia Pacific region with Japan and the Republic of Korea alone accounting for 70% of mobile broadband users.

The task of bridging the digital divide is enormous in its magnitude, and requires concerted and mutually synergistic efforts from all relevant development agencies and institutions. Towards this objective, the Economic and Social Commission for Asia and the Pacific (ESCAP) has been fostering economic and social connectivity through ICT and providing a platform for regional cooperation. It has also accorded due importance to sharing of knowledge, expertise and best practices on ICT for development within the various stakeholders.

To promote a better appreciation of the significance of ICT for socio-economic development, the Asian and Pacific Training Centre for ICT for Development (APCICT), a regional institute of ESCAP, is successfully executing its 'Academy of ICT Essentials for Government Leaders' programme in the region. To complement this effort, APCICT's Case Study Series aims to present a useful resource for compiling and disseminating best practices in ICT for development for the reference of a range of stakeholders including government agencies, international organizations, academia, non-governmental entities and the private sector. This is an important initiative with much potential to promote south-south cooperation for building a digitally inclusive society. I encourage all to take full advantage of it!

Noeleen Heyzer
Under-Secretary-General of the United Nations
and Executive Secretary of ESCAP

Preface

Over the last year, in the Asia Pacific region, we saw Typhoon Ketsana hitting the Philippines; a tsunami affecting Samoa, American Samoa and Tonga; two massive earthquakes striking the Indonesian island of Sumatra; and most recently a devastating earthquake hitting the Qinghai province of China. The series of events served to remind us that development efforts are increasingly at risk.

These disasters left over three thousand dead and millions affected. Properties and infrastructure were destroyed, livelihoods were affected, and access to health and education services was impeded. The social and economic cost of disasters has increased in recent years due to population growth, change in land use patterns, migration, unplanned urbanization and environmental degradation.

Statistics indicate that one person in twenty has been affected by disasters in any given year since 1990. The year 2008 was particularly catastrophic (partly due to Cyclone Nargis and the Sichuan Earthquake) with almost 0.25 million deaths in the region, representing 97 percent of fatalities worldwide.[1] The urgency to reduce disaster risks, therefore, is very rapidly being recognized internationally, especially with climate change threatening to further increase the frequency and severity of natural disasters. Thus, it is more important than ever to Act Now, Act Together and Act Differently.

It is fundamental to act together as disasters often affect multiple countries and sectors. Early warning and the sharing of risk information require close cooperation across countries and sectors. It is also important to act differently - to shift from a reactive mode focused only on relief and response, to a proactive approach of building disaster resilience.

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 facilitate fast flows of information, capital, ideas, people and products. With the new ICTs, in particular computers, the Internet and mobile phones, the constraints on the place and time for interaction have eased considerably. They have become essential tools for cooperation and collaboration.

ICTs have also been important tools for developing innovative solutions to development challenges. ICTs have transformed government services through improved efficiency, transparency and accountability in government and by reducing transaction times and removing redundant layers of bureaucracy.

Similarly, ICTs can play a catalytic role in reducing disaster risks now, together and differently. ICTs are important tools for lessening the risks brought on by disasters through early warning, coordinating and tracking relief activities and resources, recording and disseminating knowledge and experiences, and raising awareness. The challenge is gaining commitment to incorporate ICT tools effectively in disaster risk reduction (DRR), and providing favourable political, social and economic conditions for identifying and applying an appropriate mix of ICTs to address vulnerabilities in the different contexts throughout Asia and the Pacific.

Governments need to act swiftly and decisively to ensure that they provide an enabling environment for the use of ICTs in creative ways towards DRR. Unfortunately, many policymakers, including disaster management authorities, have yet to acquire the knowledge and skills needed to leverage opportunities provided by ICT and integrate ICT applications in their daily work. We therefore hope that this publication will contribute to a better understanding of ways in which ICTs can be used for DRR, and in turn, generate opportunities for networking, collaboration and implementation of new solutions.

This publication is the second issue in APCICT's ICT for Development (ICTD) Case Study series that provides analyses and compilations of best practices and case studies on different aspects of ICTD and capacity building in the Asia Pacific region.

The Asian and Pacific Training Centre for Information and Communication Technology for Development (APCICT) was inaugurated on 16 June 2006 as a regional institution of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) to strengthen the ICT capacity of ESCAP Member States. ESCAP has been mandated by the UN General Assembly in December 2009 to support Member States in DRR efforts, in close coordination with implementing entities of the United Nations system.

ESCAP's overall strategy on DRR is to mainstream this issue in development strategies as well as climate change adaptation efforts to strengthen regional cooperation. The Information Communications Technology and Disaster Risk Reduction Division (IDD) of ESCAP serves as a regional hub for cooperation and technical support for DRR with particular attention to countries with special needs, vulnerable social groups, poverty reduction and gender equality. Moreover, two ESCAP Commissions, namely the Committee on Disaster Risk Reduction and Committee on Information and Communications Technology, are a formal mechanism to discuss policy options and strategies on DRR, regional cooperation, good practices and lessons learnt in DRR as well as ICT applications for DRR. This issue of APCICT's ICTD Case Study series complements the ongoing DRR activities of ESCAP.

Given its commitment to promoting ICT for DRR, APCICT had previously developed a primer on ICT for Disaster Management in partnership with the United Nations Development Programme, and is also in the process of developing a training module on ICT for DRR as part of its "Academy of ICT Essentials for Government Leaders Programme" (Academy). The Academy, presently comprising of eight standalone but interrelated modules that make up a comprehensive ICTD curriculum, is currently running in over a dozen countries throughout Asia and the Pacific, and has been translated into different languages.

The primer, this publication and the upcoming training module add to the limited knowledge resources currently available on ICT for DRR. We extend our deepest appreciation to the authors of these case studies - Shanta Halder, Tasdiq Ahmed, Manzul Hazarika, Dwijendra Das, Lal Samarakoon, Li Jing, Shen Li, Tang Hong, Gasbrielle Iglesias, Novil Wijesekara, Nirmala Fernando, Peter Griffin, Chamindra de Silva, Mark Prustalis, and UNDP - for their valuable cooperation in providing expert insights on the role of ICT in DRR. A special note of recognition is extended to Christine Apikul for the publication's Introductory Chapter and her excellent editorial work. Together, we hope that these resources will contribute to the enhancement of capacities and the forging of partnerships in the effective use of ICT to save lives and achieve development targets, including those set out in the Millennium Declaration.

Xuan Zengpei
Director
IDD-ESCAP

Hyeun-Suk Rhee
Director
UN-APCICT/ESCAP

1. United Nations Economic and Social Commission for Asia and the Pacific Press Release No: G/24/2009, "Asia-Pacific Countries See the Need to Cooperate to Reduce Risk of Disasters," 25 March 2009, http://www.unescap.org/unis/press/2009/mar/g24.asp.

ICT for Disaster Risk Reduction in Asia and the Pacific

An Overview of Trends, Practices and Lessons

Christine Apikul

1. Disaster Trends in Asia and the Pacific

The Asia Pacific region is the most disaster prone region in the world, accounting for 42 percent of the world's natural disasters between 1999 and 2008. A person living in the region is 4 times more likely to be affected by natural disasters than someone living in Africa, and 25 times more likely than someone living in Europe or North America.[2]

Asia and the Pacific are well known for its fast growing economies and rich cultural diversity. But, many parts of the region have seen their economic and social development stalled, or even reversed, by natural disasters.

Table 1 illustrates the intensity of damage in the region. Compared to more developed countries, most disasters in the region have a higher number of casualties and low financial damage in absolute terms, but still quite an important figure as a share of gross domestic product (GDP).[3]

This trend of increasing disaster risks is jeopardizing the significant progress made towards meeting the UN Millennium Development Goals (MDGs). The 2004 Indian Ocean Tsunami, for example raised Aceh's poverty rate from 30 to 50 percent.[4]

Climate change threatens to further magnify the vulnerability of the poor by increasing the frequency and severity of natural disasters. About 40 percent of the world's climate-related disasters occur in Asia and the Pacific.[5]

For some people, these natural disasters are believed to be acts of God and therefore, unavoidable. Based on this belief, some countries focus on providing relief and response as quickly as possible after a disaster, to prevent further loss of life and social, economic and political damage; and this is seen to be the responsibility of relief workers, the fire brigade and the army.

Increasingly though, disasters are being recognized as resulting from unsustainable development practices - encroachment into high-risk areas due to rapid urbanization, construction of unsafe shelters, pollution, loss of biodiversity, land degradation, social discrimination, etc. These factors and processes are believed to increase people's vulnerability to disasters. Taking this perspective, the impact of disasters can be reduced or even avoided by promoting change in development practices. Disaster risk reduction (DRR) has become everybody's responsibility, and requires a wide range of political and professional collaborations and partnerships.

Disaster occurrence	Country	Number of deaths	Estimated financial loss (US$)	Financial loss as percentage of GDP
India Ocean Tsunami, 2004	Sri Lanka	→ 31 000	1.3 billion	6.4
Northern Pakistan earthquake, 2005	Pakistan	73,338	5.2 billion	4.7
Cyclone Sidr, 2007	Bangladesh	4,234	2.3 billion	3.4
Niigata/Chuetsu earthquake, 2004	Japan	40	28 billion	0.6
Wenchuan earthquake, 2008	China	87,476	20 billion	0.6
Cyclone Nargis, 2008	Myanmar	138,366	4.1 billion	21

Table 1. Comparison of damage from natural disasters

DRR can be visualized as a continuous cycle comprised of four phases - Mitigation, Preparedness, Response and Recovery (see Box 1 for their definitions). 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 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.[6]

In January 2005, 168 governments affirmed their commitment to DRR through the Hyogo Declaration and Hyogo Framework for Action (HFA) 2005-2015, a global blueprint with guiding principles and priorities for action to significantly reduce disaster losses. The latest review of progress in the implementation of the HFA by the United Nations International Strategy for Disaster Reduction

2. United Nations Economic and Social Commission for Asia and the Pacific Press Release No. G/63/2009, "Natural Disasters in Asia and the Pacific Underscore The Urgency For A Meaningful Climate Change Agreement," 1 October 2009, http://www.unescap.org/unis/press/2009/oct/g63.asp.
3. United Nations Economic and Social Commission for Asia and the Pacific, Implementation of the Hyogo Framework for Action in Asia and the Pacific: Follow-up to the Outcome of the Third Asian Ministerial Conference on Disaster Risk Reduction: From the Regional to the Global Platform, Note by the secretariat presented at the Committee on Disaster Risk Reduction First Session, 25-27 March 2009, Bangkok, Thailand, http://www.unescap.org/idd/events/cdrr-2009/CDR_INF4.pdf.
4. International Federation of Red Cross and Red Crescent Societies, World Disasters Report, Geneva, 2009, http://www.ifrc.org/publicat/wdr2009/index.asp.
5. Ibid.
6. United Nations Economic and Social Commission for Asia and the Pacific Press Release No. G/61/2008, "Asia-Pacific Governments Can Save Lives and Money By Investing in Disaster Preparedness," 2 December 2008, http://www.unescap.org/unis/press/2008/dec/g61.asp.

(UN/ISDR) shows good progress made overall, but compared to disaster damages and spending on relief, recovery and reconstruction, however, such efforts are insufficient.[7]

Box 1. Terminologies[8]

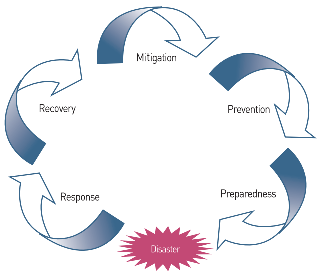

Figure 1. Disaster Risk Reduction Cycle

Disaster Risk Management - The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Disaster Risk Reduction - The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Response - 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.

Recovery - 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.[9]

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

Prevention - The outright avoidance of adverse impacts of hazards and related disasters. Examples include dams or embankments that eliminate flood risks and land-use regulations that do not permit any settlement in high risk zones. Very often the 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.

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.

2. ICT Trends and Applications for DRR in Asia and the Pacific

ICTs have proven to be an accelerator of economic and social progress. ICTs 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.[10] 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.

Access to adequate infrastructure is a prerequisite for organizations and individuals to adopt and use ICTs. Over the past decade most countries have put in place some form of ICT infrastructure, and have allowed various ICT tools to become more accessible and affordable for many developing countries. Moreover, the convergence[11] of these technologies is leading to greater possibilities for use by different sectors and stakeholders.

The different digital technologies and their use to reduce disaster risks are briefly highlighted below. This is not meant to be an exhaustive list of ICTs but provide highlights of some key ICTs that have proved indispensable to DRR. They include: mobile technology, the Internet and Web 2.0 tools, space-based technologies such as geographic information systems (GIS), remote sensing and satellite communications, and different types of radios, including amateur radio and satellite radio.

2.1 Mobile Technology

A target set by world leaders at the World Summit on the Information Society (WSIS) that more than half the world's population should have access to ICTs has been reached seven years ahead of schedule thanks to

7. ISDR, Global Assessment Report on Disaster Risk Reduction, Geneva: United Nations, 2009, http://www.preventionweb.net/english/hyogo/gar/report/index.php?id=1130&pid:34&pih:2.
8. UN/ISDR Terminology on Disaster Risk Reduction, http://www.unisdr.org/eng/terminology/terminology-2009-eng.html.
9. United Nations Secretary-General's Special Envoy for Tsunami Recovery, Lessons Learned from Tsunami Recovery: Key Propositions for Building Back Better, December 2006, http://www.preventionweb.net/english/professional/publications/v.php?id=2054.
10. UNCTAD, Information Economy Report 2009: Trends and Outlook in Turbulent Times, New York: United Nations, 2009, http://www.unctad.org/en/docs/ier2009_en.pdf.
11. Convergence brings together, in a seamless manner, the different media including text, audio, graphics, animation and video such that all are delivered on a common platform while also allowing the user to choose any combination of media to interact with. An example is the mobile phone that can be the delivery channel for text, audio, video, e-mail, SMS and Internet browsing (Source: APCICT Academy Module 1 - The Linkage between ICT Applications and Meaningful Development, http://www.unapcict.org/academy).

mobile phones.

Mobile technology is probably the most rapidly expanding technology in terms of the speed of expansion and reach to the unconnected. The technology is mostly based on voice and short message service (SMS). But with the rapid growth in mobile phone usage, more sophisticated mobile services are being introduced, the most widely known being m-banking (allowing people to pay, receive and transfer money using a mobile phone), m-commerce (the buying and selling of goods and services), m-health (for health research and healthcare delivery), and m-learning.

On average 40 per 100 people are mobile phone subscribers in Asia and the Pacific. Figures range from 26 per 100 people in South and South-West Asia to 87 per 100 people in North and Central Asia. Growth rates have been particularly impressive in the Russian Federation from 25 per 100 people in 2003 to 119 per 100 people in 2007, and also in the Maldives from 23 per 100 people to 104 per 100 people.[12]

The ubiquity of mobile phones in some countries has prompted humanitarian organizations to explore their usage for DRR, in particular for early warning. Following the 2004 Indian Ocean Tsunami, the Sri Lanka Disaster Management Centre (DMC) developed an SMS-based tsunami warning system, which was put to the test on 19 September 2007.The DMC sent out a 20-word tsunami alert via SMS following a magnitude 7.9 earthquake off the southern coast of Sumatra: "Tsunami warning for Sri Lanka north, east and south coast. People asked to move away from coast - Disaster Management Center." The message was sent to government officials, media representatives, the military, police officers and village chiefs via SMS. These agencies, in turn, contacted citizens within their district to inform them of the alert via SMS, as well as through radio and television networks. No injuries or casualties were reported and citizens returned home over the course of the next three days. However, mobile networks became jammed after the alert was issued due to the high volume of voice calls. The Sri Lankan telecommunication authority now insists that subscribers only use SMS messaging during national emergencies, so as not to overburden the networks.[13]

Subsequently, DMC Sri Lanka developed a Disaster and Emergency Warning Network in partnership with Dialog Telekom PLC, Dialog University of Moratuwa Mobile Communications Research Laboratory and Microimage Technologies that sends out SMS message crafted by the DMC to pre-identified individuals. This network is 'cell broadcast-enabled'.

2.1.1 Cell Broadcasting

Cell broadcasting (CB) has several advantages over SMS, particularly for early warning, and is being assessed and tested in a number of other countries including Bangladesh and the Maldives. While SMS is a one-to-one and one-to-a-few service, CB is a one-to-many geographically focused messaging service, which means that messages can be tailored to multiple phone subscribers located within a given part of its network coverage area at the time the message is broadcast. CB is also not as affected by traffic load; therefore, it may be used during a disaster when load spikes tend to crash networks. For countries with high mobile penetration, CB is an inexpensive technology that requires no further infrastructure as it uses the existing mobile telecommunication system. Policymakers should also be aware of the limitations. 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; and it is not infallible to hazardous events - disruption of the mobile telecommunication system would hamper optimal functioning of the CB system.

In Bangladesh, the Disaster Management Information Centre is piloting early warning dissemination through CB in two districts - Sirajgonj (for floods) and Cox's Bazaar (for cyclones). Agreements were signed with two mobile operators - Grameenphone and state-owned Teletalk - to send instant messages to their subscribers. Based on the result of the pilot, this technology will be expanded to other high risk areas of Bangladesh through the Comprehensive Disaster Management Programme or CDMP (see case study on the Programme below).

In Maldives, the Telecommunications Authority of the Maldives commissioned LIRNEasia, a regional ICT policy and regulation think tank, to conduct a scoping study on the implementation of CB as part of the national public alert system.[14] The report focuses not only on public warning but also on ways to make CB commercially viable. In higher-income countries like Japan and the Republic of Korea, CB has already been deployed nationwide for public warning for a number of years. In these countries, governments have often borne the cost of equipping the mobile network for broadcasts. Since 2005, the Netherlands has provided 2.5 million Euros to equip the mobile network of three operators for CB, and has required all operators to transmit government text warnings via cell broadcast.

Mobile technology is also being used during relief and response for communication between relief workers and between relief workers and their headquarters. Additionally, mobile technologies have been used to raise funds, and to a lesser extent, in DRR awareness raising and education. Frontline SMS is one of the most popular free and open source software (FOSS) applications[15] for sending out SMS messages to groups of people, which has been used for various development communication initiatives.[16]

2.2 Radio

Radio is another ICT that is relatively extensive in reach in Asia and the Pacific. Different types of radio have been regarded as an effective communication technology throughout all phases of DRR.

12. ESCAP, "Information and communication technology," in Statistical Yearbook for Asia and the Pacific 2008, http://www.unescap.org/stat/data/syb2008/18-ICT.pdf.
13. New Media and Development Communication, http://www.columbia.edu/itc/sipa/nelson/newmediadev/Emergencies.html.
14. Natasha Udu-gama, Mobile Cell Broadcasting for Commercial Use and Public Warning in the Maldives, LIRNEasia, May 2009, http://lirneasia.net/wp-content/uploads/2009/07/CB_Maldives_FINAL_2009_041.pdf.
15. FOSS is software that is liberally licensed to grant the right of users to study, change, and improve its design through the availability of its source code. Source: http://en.wikipedia.org/wiki/FOSS. The availability of FOSS without license fees and its inherent characteristic of being open to modification and adaptation make it an attractive proposition to poorer communities. As a result, many projects that make use of FOSS to empower and help the people have been initiated all over the world especially in poor and developing regions. For further discussions on FOSS, see section 5: Key Lessons Learned.
16. See http://www.frontlinesms.com/who/.

2.2.1 Amateur Radio

In times of crisis, amateur or 'ham' radio is often used as a means of emergency communication when other conventional means of communication become damaged or destroyed. This is because amateur radio is not as dependent on terrestrial systems that can fail.

Amateur radio operators are trained volunteers known worldwide not only for their skills to provide emergency communication facilities but also for their dedication to help save lives. There are several million volunteers across the world that 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.[17]

Most of these individuals are part of National Amateur Radio Societies. 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.[18]

News coverage about amateur radio's role in the 2004 Indian Ocean Tsunami relief effort has been widespread and positive. For example, in the Andaman and Nicobar Islands, amateur radio operators were the critical link between the islands and the Indian mainland and helped in the coordination of rescue and relief operations.

More recently, amateur radio's role in response after the Sichuan earthquake has been well documented. Within three minutes after the tremors from the Sichuan earthquake was felt in Chengdu, the capital of Sichuan, the first local amateur radio emergency network was set up. Seventeen minutes later, over 200 stations around Chengdu city had checked in to the emergency network. Upon receiving news that the local government in Hanwang, a town adjacent to the epicentre of the earthquake, had lost all communication means, a team of radio amateur walked from Chengdu to Hanwang to set up an amateur repeater and distributed some handheld transceivers. This became the major channel for coordinating local response.[19]

2.2.2 Satellite radio

Satellite radio is being pilot tested for use during emergencies. In Asia, countries such as Bangladesh, India, Indonesia, Sri Lanka and Thailand have tested the Worldspace Addressable Satellite Radios for Emergency Alerting (AREA) system that can issue hazard information directly to communities at risk. Global positioning system (GPS) technology incorporated into the radio receiver set, along with the unique code assigned to every receiver, allows for hazard warnings to be issued, in text and audio formats, to sets that are within a vulnerable area or just to radio sets with specific assigned codes.

The cost of an AREA terminal device is under US$80. However, the audio channel is what costs the most. In Sri Lanka, a large national non-governmental organization (NGO) tested the AREA system not only for transmitting alerts but also for conducting distance education on the audio channel. Additionally, communities have been using the audio channel to express their opinions on the ongoing projects in their communities. The result from the pilot test recommended that the NGO devise an appropriate business plan by charging a nominal fee to broadcast news and other programmes of the NGO to communities based on fixed weekly programme.

2.2.3 Broadcast radio

Broadcast radio has been used to disseminate early warning messages, as well as for awareness raising and community education. For example, the well-known Cyclone Preparedness Programme of Bangladesh operates an extensive network of radio communication facilities, in the coastal areas, linked to its communication centre at its head office in Dhaka. Disaster alerts are sent through the network consisting of 130 HF/VHF radio stations, which covers most of the high risk cyclone prone areas.

In Afghanistan, broadcast radio has been used successfully to raise awareness on disaster-related issues through a radio soap opera. New Home New Life (NHNL) has been broadcasted in Dari and Pashto on the BBC World Service since 1994. NHNL communicates educational messages on key developmental themes such as health, gender equity, good governance, and sustainable rural livelihoods. This is complemented by weekly educational programmes to provide additional information on the issues raised in the soap opera. Evaluation results provided clear evidence that listeners of NHNL recall the disaster-related messages from the soap opera, and some of them have even taken specific actions to prepare for disasters.[20]

In the aftermath of the 2004 Indian Ocean Tsunami, UNDP supported a radio programme in Aceh to reduce trauma. The weekly show invited a counselor and psychologist to discuss issues related to family relations, employment and income, housing conditions and community support. And listeners were able to call in or SMS their questions.[21]

2.3 Space-based Technology

Space-based technologies are increasingly being recognized as essential in improving performance during all phases of the DRR cycle, particularly for remote sensing, mapping and communication.

17. Wikipedia, "Amateur radio emergency communications," http://en.wikipedia.org/wiki/Amateur_radio_emergency_communications.
18. The International Amateur Radio Union, http://www.iaru.org.
19. Chinese Radio Sports Association, "A Report on Amateur Radio Emergency Service in Disasters in China," presented at the International Amateur Radio Union Region 3 Fourteenth Regional Conference in Christchurch, New Zealand, on 12-16 October 2009, http://www.iaru-r3.org/14r3c/docs/020.doc.
20. Anurudra Bhanot, Building Disaster Resilient Communities: Evaluating the Impact of the BBC WST's Radio Programme New Home New Life on Disaster Risk Reduction and Related Messages, BBC World Service Trust, http://downloads.bbc.co.uk/worldservice/pdf/wstrust/ECHO_Research_Report.pdf.
21. Aceh and Nias Recovery Stories: UNDP Supports Radio Program to Reduce Tsunami Trauma, July 2006, http://www.undp.or.id/tsunami/view.asp?Cat=st&FileID=20060711-1.

2.3.1 Remote Sensing

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.

In China, satellite remote sensing technology, satellite navigation and positioning technology and unmanned remote sensing aeroplane technology have been used for disaster management. China has also launched meteorological, oceanic and land resources satellite systems that are used for disaster management. Yet gaps remain in their comprehensive coverage, timeliness and all-weather observation. As a result, China is developing a dedicated satellite constellation for environment and disaster monitoring.[22] One of the case studies below provides details of China's experience in using space-based technology for DRR.

Constellations of satellites comprise different types of satellites carrying a range of sensors to better capture the characteristics of each disaster type. Two complementary types of satellites are particularly relevant to disaster management. Polar-orbiting satellites fly in a relatively low orbit and are able to provide high spatial resolution. But they can only collect data over the same point once every few days. Geostationary satellites are positioned at a much higher altitude and can provide almost constant surveillance (every 15 minutes), but their spatial resolution is low (providing less clarity and details). Both are required for disaster management to track changes in weather patterns, and to have high spatial resolution data for DRR planning.[23]

Moreover, each satellite in the constellation carries one or more sensors on board that take measurements in different wavelengths. It is recommended that different types of sensors be available to track and monitor multi-hazards. For example, data from optical and near infrared sensors can be used to map land use and assess agricultural droughts. But to track a cyclone's eye, or monitor flooded areas beneath cloud, microwave sensors are needed. For fires or volcanoes, it is thermal imagery that is needed to pick up hotspots.[24]

Some developing countries, such as China and India, have invested heavily in both Earth observation and communication technology, and launched their own satellite - or constellation of satellites - to monitor and respond to disasters. But for many other countries, barriers to using remote sensing for DRR include the cost factor. Countries may also lack the institutional infrastructure or human expertise to analyse and interpret satellite data, package the results into images, maps and explanations that can be easily understood by the targeted user, and quickly disseminate them through appropriate channels.

22. ESCAP, Implementation of the Hyogo Framework for Action in Asia and the Pacific: Case Study - The National Disaster Management system of China and its Response to the Wenchan Earthquake, Note by the secretariat presented at the Committee on Disaster Risk Reduction, First session, 25-27 March 2009, Bangkok, Thailand.
23. Ranganath Navalgund, "Disaster management needs satellite 'constellations'" SciDevNet, 11 November 2009, http://www.scidev.net/en/opinions/disaster-management-needs-satellite-constellations—1.html.
24. Ibid.

There is also a general lack of understanding and political commitment among policymakers on the use of remote sensing for DRR.

Some experts question whether it is necessary at all to invest heavily in space-based technology especially with free satellite data now available from several international organizations.25 Collaborations such as the International Charter on Space and Major Disasters - established in 1999 and now signed by nearly 20 space agencies and organizations - offer governments free satellite data to any country affected by a natural disaster.

Another example is the Operational Satellite Applications Programme (UNOSAT) of the United Nations Institute for Training and Research that supports the humanitarian community (UN and non-UN) with maps and analyses derived from satellite imagery acquired commercially or via the International Charter on Space and Major Disasters. In 2003, UNOSAT created a humanitarian rapid mapping service to help coordinate response and relief efforts.

But the International Charter can only be activated after a disaster, and cannot be exploited to help developing countries acquire data for planning mitigation and preparedness, and the cost of using satellite imageries for long-term monitoring and predicting risk remains high.[26]

Recognizing this constraint, the Group on Earth Observations (GEO) aims to support access to remote sensing data at all stages of the DRR cycle. The Global Earth Observation System of Systems (GEOSS), developed and managed by GEO promotes common technical standards so that data from the thousands of different instruments can be combined into coherent datasets. GEOSS is also responsible for GEONETCast, a global network of communication satellites and alternative web dissemination channels that transmits environmental data to disaster managers (and others). It offers data from various satellites to regional centres in Europe, Africa and Asia via a small receiving station. These centres then disseminate the data to relevant local stakeholders through digital video broadcast.[27]

GEO has also successfully been pushing space agencies to release their data for free. In 2007, it announced that the China-Brazil Earth Resources Satellite would distribute its images gratis. And NASA, following participation in the GEO Ministerial Summit in Cape Town in 2008, announced that it would make the full archive and future data from their Landsat satellites available free of charge. The decision opened up remote sensing data to thousands of users across the world.[28]

ESCAP has signed an agreement with the Japan Aerospace Exploration Agency to scale up assistance to ESCAP's member states in the use of space-based information and services, and the provision of satellite images to disaster-affected areas.

25. See Tatum Anderson, "Launching your own satellite - the pros and cons," SciDevNet, 11 November 2009, http://www.scidev.net/en/new-technologies/remote-sensing-for-natural-disasters-1/features/launching-your-own-satellite-the-pros-and-cons.html.
26. Sian Lewis, "Remote sensing for natural disasters: Facts and figures" SciDevNet, 11 November 2009, http://www.scidev.net/en/agriculture-and-environment/tropical-cyclones-1/features/remote-sensing-for-natural-disasters-facts-and-figures.html.
27. For more information about GEO, see http://www.earthobservations.org.
28. Sian Lewis, op. cit.

Another noteworthy initiative is Sentinel Asia[29] that comprises a team of 51 organizations from 18 countries to deliver remote sensing data via the Internet as easy-to-interpret information for both early warning and flood damage assessment across Asia. Led by the Asia-Pacific Regional Space Agency Forum, the system draws on satellite-derived products and imageries from all available earth observing geostationary, or low-earth orbiting satellites, including meteorological satellites that provide routine data to the region.

2.3.2 Geographic Information Systems

GIS is a vital application for transforming images generated through remote sensing to an information system that can be used to produce interactive maps, conduct spatial analyses, present results in a variety of ways, and manage the data. GIS is essentially the merging of cartography and database technology.[30]

The use of GIS and remote sensing have 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.

For mitigation, GIS can be used to identify high risk areas and prioritize them for mitigation activities. For preparedness, 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.

In India, for example, community contingency plans have been developed using GIS technology that enable the visual display of critical data by location, for use in the coordination and implementation of relief efforts.

Some of the challenges of using GIS include the lack of trained personnel; difficulties in exchanging data between different systems; and the quality and detail of the data required by GIS analysis. Recognizing the importance of trained personnel in producing GIS maps for DRR, a number of private and non-profit organizations and UN agencies are available to develop and disseminate various GIS maps, especially for use in response and recovery to meet information needs.

In the aftermath of the 2004 Indian Ocean Tsunami, for example, the OCHA-established Humanitarian Information Centre produced 'Who Is Doing What Where' maps and database. The UN Joint Logistics Centre utilized GIS to produce a detailed atlas of the damage to the transportation infrastructure in northern Sumatra, Indonesia. MapAction, a UK-based NGO, mapped the damaged areas in Sri Lanka in support of the Government of Sri Lanka. Private companies such as ESRI, EarthSat, IBM, and Trimble supported many UN agencies, government bodies and humanitarian organization with GIS software; GIS professional services; and data collection, management, and dissemination.[31]

GIS professionals are also increasingly making themselves available to support international development and humanitarian programmes through volunteer organizations. GISCorps, a not-for-profit volunteer organization, matches interested and qualified GIS professionals with programmes in need around the world.

2.3.4 Satellite Communications

Many emergency communication systems use satellite phones and, or satellite radios either as back up or a means for two-way communication during disasters as these technologies will remain functional when terrestrial networks fail. High-speed Internet access can be switched to satellites in the event of a disaster.

Satellite communications have also been used to reach the 'last mile'[32] in remote communities where terrestrial or wireless networks are not available and not considered commercially and technologically viable to set up.

Combining remote sensing satellites with communication satellites can be useful in ensuring that data generated by satellites reach disaster managers and planners. The information presented should be relevant and easy to understand. For example, India combines its Indian Remote Sensing satellite system - designed for land use and ecological monitoring - with the Indian National Satellite System communication satellites.

Being able to integrate satellite data with other geo-spatial datasets and ICTs is also important. To assess landslide risk, for example, it is important to integrate remote sensing data with population maps and other spatial databases. In South Africa, a system has been developed that combines satellite data with mobile phone technology to provide a cost effective alert system. The service is complimentary and anyone can sign up to receive alerts.[33]

2.4 The Internet

Internet use is spreading rapidly in some countries. In the Islamic Republic of Iran and Viet Nam, less than 10 percent of their population used the Internet half a decade ago. In 2008, the number of users has expanded to one third and one quarter of their respective populations. In other countries though, growth has been slower due primarily to high prices, inadequate infrastructure, and lack of content in local languages.[34]

The penetration rate of broadband technology that allows for high-speed, high-capacity transmission of

29. Sentinel Asia, http://dmss.tksc.jaxa.jp/sentinel/index.html.
30. Wikipedia, "Geographic information system," http://en.wikipedia.org/wiki/Geographic_information_system.
31. ESRI, "Assessment and Coordination of a Complex Emergency: GIS Supports Indian Ocean Tsunami Disaster Relief," ArcNews Online, Spring 2005, http://www.esri.com/news/arcnews/spring05articles/gis-supports.html.
32. Last mile is a term that has been adopted by some disaster managers because it expresses the sentiment that warnings and the means to respond to them often do not reach those who need it most ? those within the last mile. They may be people who, for reasons of age, gender, culture or wealth, are not reached by disaster preparedness programmes (Source: IFRC, 2009).
33. See http://www.scidev.net/en/new-technologies/opinions/fires-spotted-from-satellites-warned-by-phone-1.html.
34. ESCAP, 2008, op. cit.

data, voice and video signals is growing, but remains low in the region. In 2007, there were 3.5 broadband subscribers per 100 people in Asia and the Pacific. Most of the recent growth has been in the high-income economies, where almost 90 percent of the increase in the number of Internet users is based on broadband connections. However, for the Asia-Pacific region as a whole, the percentage is less than one-fifth.[35]

Fixed broadband is essential for development because there are many applications that do not run or operate effectively without sufficient bandwidth. In DRR, maps and imageries created using GIS and remote sensing are often made publicly accessible on the Internet for information, research, training, and to aid decision-making. High bandwidth will be required to make the most of these tools.

The Internet has been widely used in the response phase to report casualties and damages, and to coordinate relief. An example is the India Disaster Resource Network (IDRN)[36] initiated by the Ministry of Home Affairs of India in collaboration with the United Nations Development Programme (UNDP). IDRN is a nationwide online inventory of resources for disaster response. The IDRN lists equipment and expertise at the district level that can be rapidly mobilized during emergencies. And a decentralized system has been put in place to update the database every three months. IDRN is accessible only to authorized government officials, district level nodal persons, corporate bodies and units of the public sector.

Aimed at improving early warning and response, the Global Disaster Alert and Coordination System (GDACS)[37] of OCHA provides near real-time alerts about natural disasters around the world and tools to facilitate response coordination, including media monitoring, map catalogues and the Virtual On-Site Operations Coordination Centre (Virtual OSOCC). Information posted on GDACs is available to all with an Internet connection, except for the Virtual OSOCC that is password-protected for disaster managers in government and response organization. The Virtual OSOCC provides users with tools to create disaster alerts by e-mail and SMS that are automatically sent to subscribers. There are also tools for impact estimations, and through this system, the UN Disaster Assessment and Coordination Team can be mobilized. Another online platform is AlertNet that tracks all emergencies and provides essential tools for relief workers and journalists in response operations.

Also a tool for tracking disasters, the Global Public Health Intelligence Network developed by Health Canada in collaboration with the World Health Organization (WHO) is a secure Internet-based multilingual early-warning tool that has been programmed to continuously search global media sources such as news wires and websites to identify information about disease outbreaks and other events of potential international public health concern.

There are also online portals and communities that focus on knowledge sharing for longer-term recovery, preparedness and mitigation processes. Portals, such as PreventionWeb, ProVention Consortium and ReliefWeb, focus on providing a searchable repository of relevant resources, news and events; and communities, such as the UN Solution Exchange for Disaster Management Community and the Duryog Nivaran, emphasizes the building of an online community over time to exchange ideas and experiences and advance the field of disaster management, including the sharing of good practices and lessons learned.

GEO is a coalition of governments and international organizations that links together all existing Earth observation systems, and ensures that Earth observation data and information remain universally accessible as a global public good. Its online portal provides a platform for members to design new projects and coordinate their strategies and investments. The portal is comprised of a clearinghouse of information and services; registries for members to post their standards and components; and a Best Practices Wiki to promote interaction between members.

ICT Application	Advantages	Disadvantages
Cell Broadcasting	· Not affected by traffic load. · Will not add to congestion. · Messages can be differentiated by cells or sets of cells. · Greater authenticity of message.	· Must be literate. · Phone must be switched on. · Phone must be set to receive cell broadcasting.
GIS and Remote Sensing	· Continuous monitoring. · Spatial presentation of data. · Facilitates cooperative effort.	· Require high bandwidth. · Require high-speed networks. · Costly hardware and software · Require skilled professionals. · Difficulty capturing qualitative data.
Internet/Email	· Interactive. · Multiple sources can be checked for accuracy of information.	· Low penetration rate. · Must be literate. · Internet content in local languages may be limited.
Mobile Phone (Text SMS)	· High penetration rate. · Portable. · Relatively low cost.	· Must be literate. · No indication that message is generated by a legitimate authority. · Subject to congestion and thereby delay.
Radio	· One-to-many broadcasting. · Does not require user to be literate. · Portable.	· Less effective at night.
Satellite Communications	· Independent of terrestrial communication network that can be damaged by natural hazards.	· High cost of systems hardware and bandwidth utilization. · Unlikely to work indoors.
Telephone	· Does not require user to be literate.	· Inadequate penetration rates. · Congestion of phone lines during emergencies. · Disasters can damage infrastructure.
Television	· One-to-many broadcasting. · Does not require user to be literate.	· Less effective at night.

Table 2. The Advantages and Disadvantages of Selected ICT Applications

35. ESCAP, 2008, op. cit.
36. http://www.idrn.gov.in.
37. http://www.gdacs.org.

3. Technological convergence and the social media

The convergence of telecommunication, computing, and multimedia applications have further opened up new potential for its use in DRR and other aspects of development. Mobile phones, for example, are not only used for phone calls and messaging, but also used to capture and distribute images and videos, access the radio and television, and download music and news from the Internet.

Digitization has enabled the transmission of all kinds of communication signal, including voice, data, video, graphics and music over a network, and has contributed to the rapid rate of convergence. This has led to the growth and popularity of social media or Web/Mobile 2.0 tools.[38]

Social media provides an unprecedented level of user control and interactivity. Companies like Facebook, Yahoo! and You Tube offer platforms on the Internet for user-generated content. These platforms allow users to share and receive text and audio-visual content from a computer or mobile phone. As a result, social media has broadened access to diverse and previously unavailable data and analysis.

For DRR, avenues for receiving disaster-related information, particularly after a disaster, are increasing. Previously people relied on the mainstream media or government authorities for information, but a number of online social media tools have facilitated an increase in 'citizen journalism' that provides independent reporting and analysis on many areas of public interest, including post-disaster situations.[39] The Internet has become one of the first places that people now go to for the latest news updates. This trend was most evident after the 2004 Indian Ocean Tsunami disaster.

One particularly well-known site that emerged following the Tsunami was the South-East Asia Earthquake and Tsunami (SEA-EAT) Blog, launched within hours of the Tsunami. Initially intended as a site to aggregate news and information, it evolved into an interactive platform with calls for help and offers to assist.[40] See case study below that looks at how volunteers from different parts of the world came together to form and develop SEA-EAT.

38. The term "Web 2.0" (2004?present) is commonly associated with web applications that facilitate interactive information sharing, interoperability, user-centered design and collaboration on the World Wide Web. Examples of Web 2.0 include web-based communities, hosted services, web applications, social-networking sites, video-sharing sites, wikis, blogs, mashups and folksonomies. A Web 2.0 site allows its users to interact with other users or to change website content, in contrast to non-interactive websites where users are limited to the passive viewing of information that is provided to them (Source: http://en.wikipedia.org/wiki/Web_2.0).

39. The idea behind citizen journalism is that people without professional journalism training can use the tools of modern technology and the global distribution of the Internet to create, augment or fact-check media on their own or in collaboration with others (Source: Mark Glaser in http://en.wikipedia.org/wiki/Citizen_journalism).

40. See http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1325/1245 and http://www.tveap.org/disastercomm/Chapters_in_seperate_PDFs/Chap-2.pdf.

In most disaster events, the very first responders are not the relief workers and search and rescue teams, but regular people who happened to be at the site of the disaster. Accounts of these regular people in the local community getting together quickly to coordinate response are common. With the advancement of ICTs, offers of assistance have been extended to the global community in creating online platforms for information sharing and coordination of activities on site.

Organizations and volunteers are making innovative use of existing tools available on the Internet to save lives, particularly through social media. Some recently used tools for DRR include blogs (e.g. Wordpress), wikis (Wikipedia), web mapping (Google Maps), web-based instant messenger and voice calls over the Internet (in Skype and Yahoo!), image and video sharing sites (Flickr, YouTube), and social networking sites (Facebook, Twitter). Many of these sites are accessible via mobile phones that are connected to the Internet. Microsoft is beta-testing Vine, which is similar to Twitter, and allows users to receive real-time emergency updates from media outlets nationwide.

More recently, in the aftermath of Typhoon Ondoy and Typhoon Pepang in September/October 2009, a group of volunteers set up a site using Google Maps to document flood updates and persons needing rescue. Users will need to complete the online form, which is then sent to the group's main database for posting on the map.[41]

This, however, does not mean that mainstream media no longer plays a key role in disseminating information; they do. In fact, mainstream media agencies such as BBC and CNN have embraced citizen journalism and often provide links to these 'alternative' media from their websites. The examples above demonstrate the collective power of people and their effectiveness in disaster response when they are given the space and tools to collaborate. As shown in Table 2, different ICT tools have different advantages and limitations, but now there are increased choices, and they in most cases complement each other, filling each other's gaps, and thus the information has a higher possibility of reaching more people faster.

Because information through social media is not coming from one central and authoritative source, a common concern regarding reporting from citizens is the accuracy and reliability of the information provided. To counter these concerns, a study by Jeannette Sutton of the Natural Hazards Center in Boulder, Colorado found citizen information remarkably accurate in the aftermath of a number of disasters in the United States. She stated:

> *Many emergency managers I've talked with have expressed concerns about social media as a channel, and that the public at-large is going to be sharing misinformation. They also say there isn't a sense of organization within the online communications. But this isn't an entirely accurate perception of how social media is being used online. It's very organized. It just isn't organized through a central point. And, it's self-correcting. Those who participate on sites like Wikipedia or are invested in a particular conversation have some sort of stake in making sure the information is correct. So they put out information to correct misinformation.*[42]

41. See http://www.google.com/landing/typhoon-ondoy.html.

42. Jeannette Sutton, "The Public Uses Social Networking During Disasters to Verify Facts, Coordinate Information (Analysis, Social Media Package Part 1 of 2)," Emergency Management, 30 July 2009, http://www.emergencymgmt.com/safety/The-Public-Uses-Social-Networking.html.

To improve the credibility of citizen journalists, the Knight Citizen News Network has led the development of principles for citizen journalism focused on accuracy, thoroughness, fairness, transparency and independence.[43]

Apart from broadcasting breaking news and their use during times of crisis, the various social media have also been used in other phases of the DRR cycle - for early warning, recovery coordination, raising funds, generating awareness, campaigning and strengthening capacities. They also provide alternative avenues for psycho-social support to survivors.

When you have been evacuated from your home and community, you don't have the ability to participate onsite or to provide hands-on resources. Communicating with others can help victims cope because it gives them the ability to share information and talk about the event. Community forums where people can dialog with one another provide a very important resource for coping.[44]

Disaster management and development organizations are taking advantage of these social media for DRR. UNDP has made available the ICT for Disaster Management e-primer on Wikibooks,[45] which hosts open educational resources that can be edited and updated by all, and used for capacity building initiatives. And the Caribbean Disaster Emergency Management Agency has used Facebook to attract youths to participate in an essay and poster competition as part of its aim to raise youth awareness on comprehensive disaster management.[46]

As access to the Internet increases and more people in the region are using it, social media can be utilized to monitor people's interpretation of disaster information, including warnings and other risk messages, so that these messages can be fine-tuned based on how people are responding to them, and new information can be pushed out to correct any inaccuracies.

What is still missing, however, are in-depth research studies and systematic impact analyses showing evidence of ICTs as contributing to better, more effective and efficient DRR. Nonetheless, there is a growing awareness of the importance of ICT for DRR, and the next section examines various innovative ICT applications that have been used at different phases of the DRR cycle, in order to draw out some key lessons learned for policymakers to maximize the potential of ICT for DRR.

43. See http://www.kcnn.org/principles.
44. Jeannette Sutton, "Social Media Brings Together Resources, Creates More Resilient Communities (Analysis, Social Media Package Part 2 of 2)," Emergency Management, 31 July 2009,http://www.emergencymgmt.com/safety/Social-Media-Brings-Together-Resources.html.
45. ICT for Disaster Management Wikibook, http://en.wikibooks.org/wiki/ICT_for_Disaster_Management.
46. See http://www.facebook.com/pages/Comprehensive-Disaster-Management-Conference-Essay-and-Poster-Competition/133761107939?v=wall.

4. ICT Applications for DRR

The importance of ICT for DRR is recognized at international arenas such as the World Summit on the Information Society (WSIS). The WSIS Plan of Action specifically mentions the use of ICT for humanitarian assistance during disaster relief, and for forecasting and monitoring the impact of disasters.

The application of ICTs can be divided into two broad usages in disaster management. The first set of usage is associated with knowing the risks, including being aware of them and having access to relevant information on these risks to be able to minimize these risks in a timely manner. ICT applications that are used to enhance information management, forecasting, modeling, monitoring and risk mapping in support of decision-making falls into this category. It also includes ICT applications for teaching and learning, and for raising awareness that are all critical for developing a 'culture' of DRR, as well as building specific skills set required by disaster managers.

The second area of usage focuses on how best to manage risks and disasters by utilizing available ICT tools, including the Internet, phones, television and radio, in alerting communities of impending disasters, in coordinating response and rescue, and in managing mitigation programmes and projects.

Below, the application of ICTs during different phases of the DRR cycle will be discussed, starting with the use of ICT for strengthening early warning systems (EWS), since it has recently received most attention. In line with the latest thinking, this publication sees and discusses EWS as an integral part of DRR that require effective communication, preparedness planning, multi-stakeholder cooperation and the conduct of risk assessments to better under the risks. Therefore, the good practices and lessons learned presented in section 4.1 on EWS appliy to overall DRR as well.

Section 4.2 focuses on the use of ICT for disaster mitigation. The effective use of ICTs in this phase often receives the least attention as it is the time of calm in between disasters. As a result, the author has made significant effort to demonstrate the wide ranging programmes and projects that utilize ICTs as tools to help generate the momentum to reduce disaster risks, build sustained systems and networks, and develop synergies that contribute to wider development goals.

Section 4.3 examines the use of ICTs in the response and recovery phases. In contrast to ICT usage in mitigation, the field of emergency communication is more widely documented. This section highlights key interventions in Asia and the Pacific focused particularly on experiences relating to interoperability between technologies and systems, and the development of open standards and free and open source software to facilitate interoperability.

4.1 Early Warning Systems

Recent major disasters have brought to the fore the importance of EWS and, in response, a number of conferences and analyses examined the elements and processes of EWS. From these efforts, there emerges a consensus that "early warning is not only the production of technically accurate warnings but also a system that requires an understanding of risk and a link between producers and consumers of warning information, with the ultimate goal of triggering action to prevent or mitigate a disaster,"[47] making early warning a key component of DRR.

This analysis has broken EWS into four separate but interlinked elements as follows:

1. Risk knowledge
2. Technical monitoring and warning service
3. Dissemination and communication of warnings
4. Response capability and preparedness to act (by authorities and by those at risk)

Previously, development of an EWS focused largely on the second element in developing systems to monitor and detect hazards, and establish institutional mechanisms for the generation and issuance of warnings. But recent disasters clearly showed that the production of technically sound warnings can be futile without prior assessment of what the risks are or without a clear dissemination strategy and appropriate response capacity.

For example, the devastation caused by Cyclone Nargis in Myanmar in 2008 was not due to a technical failure in the early warning service - warnings were provided by the Myanmar Meteorological Service - but due to a failure in the other elements of the EWS, especially communication and preparedness to act.[48] ICTs can be effective tools in improving both these aspects of the EWS.

4.1.1 Communication

By and large, warnings are transmitted from a national (or sometimes international) technical agency through multiple receivers before they reach the at-risk communities. To avoid delay and distortion in the process, the development of international standards such as the Common Alerting Protocol (CAP) is important.

The CAP provides a general format for exchanging emergency alerts and public warnings between different alerting technologies. It is a set of ordered data that encapsulates all the information for an alert. It includes information such as the area, urgency, severity, certainty, headline, description, event, category, message type, and scope, as well as response type, sender, effective time, and message type.[49]

47. IFRC, World Disasters Report 2009: Early Warning and Early Action, Geneva: IFRC, 2009, p. 17, http://www.ifrc.org.
48. Ibid.
49. To see what a CAP message looks like go to http://www.weather.gov/alerts/ and select the CAP message of any state.

CAP allows a warning message to be consistently disseminated simultaneously over many warning systems to many ICT applications, which thus increases warning effectiveness and reduces costs. The system will also simplify the work of alerting officials by giving them a write-it-once method for issuing warnings over multiple dissemination systems without duplicate effort.[50]

The actual alert message itself needs to be carefully crafted so that it is clear and succinct, with guidance that incorporates the values, concerns and interests of those who will need to take protective action, so that the message is easily understandable and unambiguous. For example, in reference to evacuation, it is less effective to say, "Get to high ground" than to say : "By 'evacuate to high ground', we mean climb the slopes around town until you are higher than the tallest buildings."[51]

Even with well-coordinated structures and well-crafted messages, dissemination to remote areas is still difficult in many places and requires a combination of technological and non-technological solutions. There is no 'one size fits all' solution to last-mile communication - the participation of community members in deciding the appropriate communication tools and processes is essential to ensure that warnings reach them in a timely manner.

LIRNEasia, with funding support from the International Development Research Centre, initiated an action research project (the HazInfo Project) in Sri Lanka during 2006 and 2007 to study which ICT applications and community mobilization methods could work effectively in disseminating information on hazards faced by selected coastal communities.[52]

The project involved Sarvodaya, Sri Lanka's largest NGO whose work encompasses 15,000 villages throughout Sri Lanka. Sarvodaya established a Hazard Information Hub (HIH) to maintain 24/7 links with the government's designated disaster warning agencies as well as with international sources monitoring various hazards in the Indian Ocean region. Thirty-two Tsunami-affected villages that belong to Sarvodya's network of villages were selected for the study, and volunteers from these villages were trained in community-based disaster preparedness, and subsequently undertook a participatory risk mapping exercise, developed an emergency response plan and decided on early warning procedures with members from their respective community. To assess the outcome of the different components, simulated drills were conducted.

Five tools in eight combinations were tested for their reliability and effectiveness in transmitting information from the HIH to the villages. They included:[53]

- Fixed telephones (using wireless CDMA technology)
- Java-enabled mobile phones customized to carry text alerts in English, Sinhala and Tamil

50. The CAP 1.0 specification was approved by the Organization for the Advancement of Structured Information Standards (OASIS) in April 2004 and updated to CAP 1.1 specification in October 2005. In 2007, the International Telecommunication Union adopted the CAP as Recommendation X.1303. For more information, see http://www.oasis-emergency.org/cap, http://www.oasis-open.org/committees/download.php/15135/emergency-CAPv1.1-Corrected_DOM.pdf, http://en.wikipedia.org/wiki/Common_Alerting_Protocol.
51. IFRC, op. cit., p. 47.
52. See Nalaka Gunawardene and Frederick Noronha, ed., Communicating Disasters: An Asia Pacific Resource Book, Sri Lanka: TVEAP and Bangkok: UNDP, December 2007, http://www.apdip.net/news/communicatingdisasters/; and http://lirneasia.net/projects/2006-07/evaluating-last-mile-hazard-information-dissemination-hazinfo/.
53. Gunawardene and Noronha, op. cit., p. 92.

- Very Small Aperture Satellite Terminals
- Addressable Radios for Emergency Alerts (AREA), developed by the WorldSpace Corporation
- A remote alarm device (RAD) developed by Dialog Telekom and University of Moratuwa

The project not only evaluated the ICTs, but also studied the extent to which training and the level of organizational development in a village influenced community responses; and how women participated in these exercises.

Results from the research revealed that AREA combined with fixed or mobile phones were the most effective and reliable in communicating warning. Under normal circumstances, AREA can work as a radio, receiving digital radio transmissions from WorldSpace satellites. In the event of an impending hazard, they can be switched on remotely from a central location, whether or not the user has turned it on at that moment, converting them instantly into a hazard alert system. Each radio has an in-built GPS and a unique code. This enables hazard warnings to be issued to only those units known to be within a vulnerable area, or just to those units with specific assigned codes. Mobile and fixed phones, on their own, were also found to be reliable, although having two communication technologies ensured at least one would work at critical moments. AREA and RAD units also worked well as a combination.

The lack of access to ICT and connectivity is a critical bottleneck in establishing end-to-end EWS. But as indicated at the beginning of the chapter, the ICT access and connectivity is increasing at rapid rates with technological advancements, including space-based technologies. It is therefore important to stress the need for a mix of technology and a combination of technological and non-technological solutions to reach the last mile. For example, the Bangladesh Red Cross uses megaphones and hand sirens, and the Sri Lanka villages from the HazInfo project use runners and loud-speakers and/or temple bells. The appropriate mix of communication channels will need to be determined by the communities themselves through a participatory planning process.

ICTs can be used to enhance global, regional and national cooperation in early warning, where global information networks of the World Meteorological Organization, Food and Agriculture Organization, WHO, UN/ISDR, etc. support national and local EWS. ICTs are also indispensable for regular two-way communication between national and local authorities and the communities, as the role of communities in early warning is increasingly being recognized as important, particularly in their participation in monitoring hazards (e.g. in reading flood markers and rain gauges, and transmitting data in real time over handheld, two-way radios with a city flood-monitoring station). Effective channels of communication are also required in complementing technical warnings with communities' local and indigenous knowledge of early warning signs (e.g. colour of the river water, size and type of debris in river, animal behaviour, etc.); and for communities to provide feedback to the warning providers about how they understood the warnings and how they might be made more actionable or comprehensible.

4.1.2 Preparedness

People's willingness or ability to take appropriate actions when warnings are received can be affected by various factors, many of which can be overcome through preparedness. People are more likely to pay attention to warnings if they have been educated about the risks in advance and know what actions to take. Public education campaigns, including incorporating disaster risk awareness into school curricula, can contribute to a culture of safety. For schools with computers and Internet connectivity, these ICT tools can be incorporated into raising disaster risk awareness, e.g. through 'SchoolNets' - a recognizable national or regional network of teachers, students and communities to learn together, share experiences and support each other. A number of radio programmes such as Afghanistan's New Life Project are used to promote disaster preparedness. Sri Lanka has explored the use of television soap operas to raise public awareness on landslide risks.

But preparedness does not just end with the provision of information. There is a growing recognition that vulnerable communities can and should be engaged in developing their disaster preparedness and response plans, involved in regular drills to test the effectiveness of the early warning dissemination processes and responses, and even participate in the design of EWS and preparedness programmes.

One of the ways to begin engagement with community members is through conduct of risk assessments. The concept of participatory GIS (PGIS) for risk mapping takes advantage of the capabilities of GIS to produce a visual representation of place-specific local knowledge, which can then be disseminated among the community members and to local authorities (see section on Risk Assessment below for more discussions on PGIS).

4.1.3 Risk Assessment

ICTs play a significant role in addressing the first element of the EWS in improving risk knowledge, particularly in the areas of data collection, analysis and dissemination. Remote sensing and GIS capabilities through seismographic networks, deep ocean sensors and satellite-based systems are being used to develop effective EWS. GIS technology, for example, is used to predict what hazards might potentially impact a region or a specific project; assess physical assets to provide more accurate information on how to protect investments; and suggest alternatives available to reduce the direct and indirect impacts.

Maps and GIS technologies are ideal for capturing the physical dimensions, but their use in analysing the vulnerability aspects due to people's social, political and cultural conditions, their perception of risk and their coping capacity proved more challenging. Nonetheless, research and pilot initiatives have been conducted to capture these vulnerability aspects at the community level using maps and GIS.

A research study[54] carried out by the Aon Benfield UCL Hazard Research Centre demonstrated that local community knowledge related to flooding can be systematically structured into spatial and non-spatial information compatible with a GIS, through a practice named 'participatory GIS' - essentially the use of geo-spatial technologies to promote interactive participation of stakeholders in generating, managing, analysing and communicating their knowledge.

54. Graciela Peters, Michael McCall, Cees van Westen, Coping Strategies and Manageability: How Participatory Geographic Information Systems can Transform Local Knowledge into Better Policies for Disaster Risk Management, Aon Benfield UCL Hazard Research Centre, Disaster Studies Working Paper 22, February 2009, http://www.abuhrc.org/Publications/Working%20Paper%2022.pdf.

This practice has made community knowledge, experience, perception and coping capacity more visual and accessible, contributing to a better understanding of risks. At the same time, it has helped initiate dialogue and partnership between the vulnerable communities and other actors in DRR, including government authorities, NGOs, international agencies, academia and the private sector.

PGIS can be a powerful tool for enhancing communities' capacity and building their resilience to disaster risks. It is also extremely helpful in managing preparedness at the local level by providing local authorities with better indicators than just typical GIS information on water depth and flood duration or population characteristics. Additionally, it can help promote learning among different actors by bringing new information and perspectives into decision-making processes.

The UNU-ITC School for Disaster Geo-information Management recognizes the value of local knowledge for DRR and is carrying out research on the integration of local knowledge on frequent hazards, with data from remote sensing images.

The Asian Disaster Preparedness Center (ADPC), an advocate and pioneer in many aspects of community-based disaster management, has initiated pilot projects that demonstrate the benefit of involving communities in the mapping process. Communities often develop maps as part of their community-based risk assessment exercise. The process encourages community-wide participation and discussions on the risks they face. Communities have used their maps to plan evacuation routes, emergency response and small-scale disaster-mitigation projects. In one of ADPC's projects in Dagupan City, Philippines, community maps have been used as input to the city's disaster information management system, resulting in a working end-to-end flood EWS. One of the case studies contributed by ADPC, looks at the use of ICTs in a community-based EWS system in Sri Lanka.

As mentioned at the beginning of this section, the various practices described are relevant to DRR in general. Risks assessments are useful not only for early warning, but also for policy formulation, programme design, and evaluation of interventions, and are carried out at all phases of the DRR cycle, albeit at different levels of detail and emphasis. While the response phase involves the conduct of rapid damage and needs assessment to allow for quick decisions to be made, programmes and projects that are focused on mitigating risks should include in their planning process, an extensive assessment process.

4.2 Mitigation

Mitigation is usually incorporated in mid- to long-term DRR strategies that are focused on minimizing the adverse impacts of hazards and related disasters. The presence of data and information is crucial to helping decision makers understand the root causes of a disaster so that informed decisions can be made in order to, as much as possible, avoid an event from turning into a disaster.[55] Root causes can be related to poverty, inequality, illiteracy and other aspects of vulnerability.

55. Disasters occur when a potentially dangerous natural phenomenon impacts vulnerable people (or their houses, organizations or cultures) who then cannot cope with these natural forces and their destructive effects.

4.2.1 Databases for Policymaking and Planning

Information on different aspects of DRR is expanding rapidly, and access to the information is becoming easier through ICTs. Resources, previously considered the domain of specialists, now reach a wider range of users. The number of interested people, educational institutions, organizations and local community users is growing, as are relevant websites, networks, professional and often multidisciplinary exchanges online and offline.

A number of disaster databases, for example, are now available online to the public. The Centre for Research on Epidemiology of Disasters (CRED) maintains EM-DAT, a global database of natural disasters that contains essential data on the occurrence and effects of more than 17,000 disasters worldwide from the period of 1900 to the present. Reinsurance companies such as Munich Re and Swiss Re also maintain global disaster databases to assess insurance risk. But for these corporate databases, there is a lack of statistics in poor areas where insurance is unaffordable or unavailable.[56]

At the national level, UNDP has been promoting the establishment of nationally-owned disaster loss databases to better analyse the disaster trends and impacts at the sub-national level (see case study by UNDP below).

These databases are extremely useful for policymaking, planning and research. But the development of these databases is not without challenges and constraints. A key constraint is the unavailability of a standardized approach to collecting and defining/classifying different aspects of disaster. Another is the lack of data in many developing countries. Looking at natural disasters over the last decade, data on deaths are missing for around one-tenth of reported disasters, data on people affected are missing for around one-fifth of disasters, and data on economic damages are missing for 67 percent of disasters.[57] CRED deals with these challenges by constantly revisiting, reviewing and verifying the data.

4.2.2 Databases for improving transparency and accountability

Also developed by UNDP, the web-based Development Assistance Database (DAD) is an aid information management tool for tracking the use of aid received for response and recovery after the 2004 Indian Ocean Tsunami. The Governments of Indonesia, Maldives, Sri Lanka and Thailand have established nationally owned systems of DAD. Additionally, a regional information portal has been developed as a resource for coordination at the regional level. It brings together results and resource-allocation information from each country and makes them available online.

While almost US$8 billion of assistance was tracked on DAD, the customized systems were faced with a number of challenges.

> *... as one observer from Maldives put it, "high-tech, but also high-maintenance." A major challenge facing all countries trying to improve accountability was achieving the cooperation of all parties to provide accurate, updated tracking of tsunami assistance online. Moreover, sometimes self-*

56. IFRC, op. cit.
57. IFRC, op. cit.

reporting by development agencies fell short. As a result, in Sri Lanka, for example, despite strong Government efforts to encourage development organizations to report expenditures, the system apparently had not captured between US$500 million and $1 billion as of March 2006, including funds already disbursed. Agencies struggled to break their contributions down by district. To go beyond a database and ensure systems really help lock in improved accountability, according to the Maldives observer, "you need a senior, seasoned person," with a clear vision of how the various pieces of the puzzle fit together.[58]

In the Indonesian province of Aceh, the Aceh-Nias Rehabilitation and Reconstruction Agency (BRR) promoted a number of initiatives to help overcome some of the challenges described above. For instance, to encourage organizations to update the customized DAD database (named the Recovery Aceh-Nias Database or RAND), BRR contacted major donors, key users in BRR, and provincial and district governments, to identify their information needs and the types of format they need the information in. The database was customized accordingly.

In another initiative, BRR encouraged many NGOs that were not yet online to send BRR their data in a CD-ROM, which BRR staff uploaded. Later, an Outreach Team was established that provided a help desk function as well as developed customized reports as requested by donors and other users of RAND. These initiatives helped RAND gain credibility and increased its level of updating from 35 to 98 percent. RAND won the Innovative Government Technology Award in the Information Management category at the 2008 FutureGov Summit.

Data on RAND provided the basis for another innovative ICT application by BRR - the Aceh and Nias Housing Geospatial Database - that was used to monitor housing reconstruction in the effort to promote transparency and minimize corruption. This database allows the process of tracking and monitoring reconstruction to be systematically recorded in the database. The information is first gathered from RAND, then verified by field teams and digitally mapped for GPS coordinates, followed by the building of a text database. In its finest detail, each entry in the database includes a picture of the house, its GPS coordinates, the name of the house's present owner, the building contractor, and the organization that helped build it. The housing geospatial database has been merged with another database covering all other assets - bridges, hospitals, schools, roads - creating a combined information system that is one of the most comprehensive and 'leak-proof' in the recovery phase.[59]

4.2.3 GIS for mitigation

Recognizing the importance of making global disaster risk more visible as a key step towards mobilizing the political and economic commitment needed to reduce it, and in the attempt to bring together reliable data from various credible sources, the PREVIEW Global Risk Data Platform[60] was developed. Initiated by the United Nations Environment Programme in 1999, PREVIEW recently underwent major improvements in application and data to support the analyses for the 2009 Global Assessment Report on Disaster Risk Reduction of UN/ISDR.

PREVIEW uses GIS technology, which as explained above, has been widely used for the presentation and analysis of hazards, vulnerabilities and risks. Developed by a large, interdisciplinary group of researchers from around the world, PREVIEW shares spatial data information on risks related to tropical cyclones and related storm surges, drought, earthquakes, biomass fires, floods, landslides, tsunamis and volcanic eruptions. Users can zoom in on a particular area, choose layers to display, such as population distribution, GDP per capita, elevation or land cover against the natural hazards, to show the risk areas. Users can choose to visualize, download or use the data live in a GIS software.

Other examples of platforms and systems using GIS technology to present, analyse and share geospatial information include the Typhoon Committee's[61] forthcoming web-based disaster information system that aims to facilitate timely access to typhoon-related disaster information through the Internet. It will also serve as a platform for members to share disaster data, knowledge, experiences, good practices and other information related to typhoon disaster risk reduction. The Pacific Disaster Center's Asia Pacific Natural Hazards and Vulnerabilities Atlases, an online GIS tool that combines baseline geographic and infrastructure data layers with historical as well as near-real time data on multi-hazard events, is another example. Hits on this tool rose by 300 percent during the aftermath of the 2004 Indian Ocean Tsunami.[62]

4.2.4 Knowledge, innovation and education

Information by itself is not knowledge. Just being aware of a danger does not automatically lead to a reduction of the risks. It is therefore imperative to train and promote continuous learning in vulnerable communities towards enhancing their capacity in finding appropriate risk reduction solutions and techniques. It is also important to promote risk education among decision makers, highlighting the way a 'development' decisions can impact risks. This is because many decisions affecting vulnerable communities are driven by external decision makers, including national and local governments and private companies. In some cases, these decisions are even taken in another country (particularly in the case of trans-boundary river management that can lead to flooding in the lower part of the watershed).

The 2009 UN/ISDR Global Assessment Report on Disaster Risk Reduction reports that the average global progress is weak across most areas of HFA Priority for Action 3 - using knowledge, innovation and education to build a culture of safety and resilience at all levels. As ICTs become ubiquitous across the globe and within the region, it is ever more important to take advantage of the potential of ICTs to share knowledge, and promote awareness, education and innovations to reduce disaster risks.

A number of online portals with disaster-related resources are accessible through the Internet, the most popular being PreventionWeb and ReliefWeb. They not only provide an aggregation of news on

58. Tsunami Global Lessons Learned Project, The Tsunami Legacy: Innovation, Breakthroughs and Change, 2009.
59. Ibid.
60. See http://www.grid.unep.ch/activities/earlywarning/preview/index.php.

61. The Typhoon Committee is an intergovernmental body officially established in December 1968 under the auspices of ESCAP and the World Meteorological Organization to promote and coordinate the planning and implementation of measures required to minimize the loss of life and material damage caused by typhoons. The Typhoon Committee is composed of 14 members from the Asia Pacific region.
62. See http://www.pdc.org/atlas/ and http://demo.pdc.org/pdf/factsheets/Atlas2.pdf.

disaster events, but also include training materials, maps, videos, research studies and other resources that can be used to raise awareness and advocate for DRR. Furthermore, the Web 2.0 phenomenon has added a collaborative dimension to many of these portals and networks. PreventionWeb, for instance, provides the opportunity for individual to contribute resources, events and organization contacts. It also offers to provide free tools and advice to anyone interested in setting up a network or online community on DRR-related issues.

Nonetheless, the use of ICT devices and systems is still limited in many countries and alternative models are needed to provide connectivity in low and no-bandwidth environments. For example, one of the case studies below looks at the role of the Community Tsunami Early-warning Centre (CTEC), established in Peraliya, Sri Lanka after the 2004 Indian Ocean Tsunami, which is equipped with some ICT tools such as radios, telephones, a satellite television, computers and Internet access. One of its activities includes the involvement of community volunteers in monitoring seismic activity and other natural disasters on the Internet. Any relevant information online is then translated and posted on notice boards. CTEC also holds public awareness events on DRR. One of the activities involved showing videos of community-based disaster risk management activities in other countries to prompt discussions among the community.

The Red Cross Red Crescent Climate Centre in partnership with Red Cross and Red Crescent Societies also uses video tools in their community projects that are aimed at raising awareness on extreme weather events and climate change, and working with communities to identify coping strategies. A methodology called 'participatory video' has been used in which a group or community is involved in producing a video from developing the storyboard, to interviewing people and operating the camera. The rationale for investing in participatory video is based on its huge potential to change human behaviour - the key element of reducing disaster risks and adapting to climate change. Videos' audiovisual ability can portray the human-side of technically complex issues, and effectively capture people's experiences and emotions in ways that can inspire and motivate change.

> *After a workshop on flooding and climate change with Mozambican farmers, participants watched a four-minute video from a similar workshop held in a flood-prone Argentinean shanty town. After seeing the short film on a laptop screen, one of the women farmers said to the workshop facilitator: "I had followed your explanations of global warming, but didn't fully believe you... We've had the 2000 floods that killed so many people and since then two dry spells, and like everybody else I thought it was God punishing us, or that the ancestors were angry... and we can't do much about it. But now in the film I see that white women in the other end of the world have the same problem we have! So maybe it is true that the global rainfall is changing, and so if I can do something about it, I will." The video had touched this farmer in a way that motivated her to consider changing crops to adapt to different climatic conditions.*[63]

Media agencies for television and newspaper can also play key roles in raising public awareness.

63. IFRC, op. cit., p. 108-109.

Although media coverage is still largely focused on major disaster events and the immediate dramatic aftermath, there is a growing recognition of the need to include media representatives and journalists in mitigation programmes and targeted as a group for training to encourage reporting on DRR before a disaster occurs. For example, Inter-Press Service Asia-Pacific had a special series on the 2004 Indian Ocean Tsunami that invited applications from journalists residing in Tsunami-affected countries to report on another Tsunami-hit nation, to produce stories linking the two and learning from each other's DRR experiences. The challenge is in sustaining public interest, and keeping important stakeholders actively interested and engaged in the efforts, in times of calm. But it is the time between disasters when DRR capacities must be strengthened if future losses are to be avoided.

The potential of e-learning, distance education, open learning or online learning tools that make use of the Internet and multimedia technologies (combining video, sound, animation, text and graphics) to impart DRR knowledge should also be tapped. The National Institute of Disaster Management in India has collaborated with the World Bank Institute in offering a series of online training courses on DRR.[64] APCICT is in the process of developing an ICT for DRR training module as part of its Academy of ICT Essentials for Government Leaders Programme (Academy) that comprises a comprehensive ICT for development curriculum with a number of standalone but interlinked modules. The ICT for DRR module, like the other modules of the Academy, will be repackaged into a self-paced online course and made available on a learning management system - the APCICT Virtual Academy (AVA). The system offers: video lecture synchronized with presentation; self-assessment and review quiz; learning resources downloading; and learner's tracking and progress monitoring system. There is the option for users from countries with limited connectivity to choose a bandwidth matching their situation (300k, 100k, 52k or audio only). For users with no or limited Internet connection, the DVD version of AVA provides an almost identical technology platform and a comparable learning experience. AVA has been developed as part of APCICT's strategy to diversify its delivery channel, extend outreach in a cost effective manner, attract a broader user base, and encourage continuous and self-learning.

4.2.5 Enhancement of internal organizational effectiveness

To improve the internal efficiency and effectiveness of DRR organizations, particularly for international or regional organizations with country offices, many have made use of online applications to manage information, share knowledge and coordinate activities. The International Federation of Red Cross and Red Crescent Societies (IFRC), comprising of about 60 regional and country delegations around the world and 185 member Red Cross and Red Crescent Societies, has established FedNet, an extranet - a private web site for National Societies, staff at Headquarters and field delegations. Through this online platform, IFRC employees and volunteers worldwide are able to access key resources required in their day-to-day operations. It also provides an interactive forum for knowledge sharing and online collaboration. FedNet runs on a web content management system[65] called Synkron.web. This system was chosen because of its ability to integrate with other information systems which were already in

64. See http://www.nidm.net/WBI_09.pdf.
65. A content management system is a software program that allows non-technical users to edit, update, maintain, and create a website using built-in templates.

existence in the Federation.

UNDP established a Solutions Network of Asia-Pacific or the SNAP Platform, built on the Microsoft Solution Sharing Network program, and used for knowledge sharing and collaboration to improve the effectiveness of UNDP programmes and projects. SNAP is the virtual 'home' for the DRM-Asia community of practice established by UNDP in 2006 to share knowledge among the disaster risk management community in Asia and the Pacific. Initially an internal community of UNDP practitioners only, it has now expanded its membership beyond UNDP.

4.3 Response and Recovery

When a disaster strikes, there are a handful of organizations that are ready to provide assistance. In providing emergency communication, the International Telecommunication Union (ITU), for instance, deploys mobile satellite terminals and various other communications equipment to help restore vital communication links for the coordination of relief operations. This is part of the ITU Framework for Cooperation in Emergencies that has benefited from the contribution of funds and equipment from its partners - FedEx, ICO Global Communications, Inmarsat, Iridium, TerreStar Global, Thuraya and Vizada.[66]

Another key player in emergency communication is Telecoms Sans Frontiéres (TSF) that is involved in the provision of communications to UN agencies and humanitarian organizations to coordinate emergency relief, and in providing those affected by the disaster a free phone call. Recently, TSF has also been working with various countries in strengthening their capacities to respond to disasters through training and by expanding the ICT infrastructure.[67]

Most data needed in a disaster are geospatial. The first questions typically asked are related to the location of the disaster event: "Where is it? What is in the area? How do I get there?" Collaborations such as the International Charter on Space and Major Disasters and other organizations are ready to provide satellite images and GIS analyses to aid response and recovery, as discussed in the section on GIS above.

More recently, with the growing popularity of Web 2.0 tools, they have been used as a mechanism for the coordination of response and recovery initiatives. Hundreds of blogs emerged in the first few days following the 2004 Indian Ocean Tsunami. These were used for providing instantaneous situation reports, information sharing, locating missing persons and fund raising. One of the case studies below provides a personal account of a blogger who led the development of an online initiative that started out as TsunamiHelp, and became the widely recognized South-East Asia Earthquake and Tsunami Blog, known also as the SEA-EAT blog.

This trend was also evident following Typhoon Ondoy in the Philippines in September 2009 when volunteers from the Philippines and across the world came together to provide, organize and disseminate information online through sites such as Facebook, Multiply, Plurk and Twitter. People turned to these sites for up-to-the minute reports regarding what was affected, what was needed, what resources were available, and as aid began arriving spontaneously, what was coming and when. Affected organizations and individuals used the site to post requests for assistance, while volunteers and other individuals and organizations responded with the goods or human resources needed. This was possible because although the storm cut power, telephone and water supply in many areas, Internet connections were generally not affected.[68]

Also in the Philippines, what started as an initiative by a local Web developer who volunteered his time to set up a Google Maps page to document flood updates and persons needing rescue was quickly supported by major organizations such as GMA and ABS-CBN news networks, who embedded the map in their respective news sites; and by Google who helped make the page more visible by putting the link to it below the keyword search box at the Google Philippines home page. Google software engineers, staff from the two news networks and willing Filipinos pitched in by improving the capabilities and interface of the map facility. By then, the site had become a central hub of information regarding the latest developments with the relief efforts.[69] Other noteworthy initiatives that have emerged from the typhoon are Rescue InfoHub Central[70] using Google spreadsheet and Bayanihan Online that aggregated relevant 'tweets' from Twitter.[71] This Philippine case has also shown successful examples of online fundraising. PhilippineAid.com and Txtpower.org have raised significant funds for the Philippines National Red Cross.

A study found that being able to participate in social media is a great benefit to those who are directly affected by disaster because it gives them something to do. It allows those who have been evacuated from their home to participate in an online 'community' and provide the latest updates and information. Communicating with others can help survivors cope because it gives them the ability to share information and talk about the event.[72]

Indonesia effectively used radio to help reduce the trauma of survivors after the 2004 Indian Ocean Tsunami. A weekly one-hour programme assisted by UNDP was launched for the 13,000 internally displaced in Meulaboh, Aceh. The radio programme covered topics derived from interactions with the community, such as how to control emotions, family relations, employment and income, housing conditions and establishing a community support network. A counselor and a psychologist provided advice on how to cope with various forms of stress. To promote two-way communication, listeners could send in an SMS to ask questions.[73]

66. See http://www.developingtelecoms.com/itu-restores-telecoms-links-vital-for-sichuans-rehabilitation-effort.html.
67. Diane Coyle and Patrick Meier, New Technologies in Emergencies and Conflicts: The Role of Information and Social Networks, Washington, D.C. and London, UK: UN Foundation-Vodafone Foundation Partnership, 2009, http://www.unfoundation.org/press-center/publications/new-technologies-emergencies-conflicts.html.
68. John Mark V. Tuazon, "Disaster Management 2.0," Computerworld Philippines, 6 October 2009, http://computerworld.com.ph/disaster-management-20/. See also http://newsinfo.inquirer.net/inquirerheadlines/nation/view/20090928-227233/Netizens-help-victims-via-social-network-sites.
69. See http://sites.google.com/site/ondoymanila/, http://www.google.com/landing/typhoon-ondoy.html, http://www.abs-cbnnews.com/nation/09/27/09/ondoy-situation-map-metro-manila-google-maps#Map, http://maps.google.com/maps/ms?ie=UTF8&hl=en&t=p&source=embed&msa=0&msid=100693175203414818292.00047501c97fd73a79b85&ll=15.315976,122.124023&spn=7.412133,9.338379&z=6.
70. See http://spreadsheets.google.com/ccc?key=0Ai4KmPHsK-wPdG9odTlrdGhOVTZhbmxmMjFMb3cwOGc&hl=en.
71. See http://bayanihanonline.wordpress.com.
72. Jeannette Sutton, 31 July 2009, op. cit.
73. UNDP, "Aceh and Nias Recovery: UNDP Supports Radio Program to Reduce Tsunami Trauma," July 2006, http://www.undp.or.id/tsunami/view.asp?Cat=st&FileID=20060711-1.

4.3.1 Emergency Response Planning

For effective response, emergency response planning before disaster strikes is absolutely critical. As part of this emergency planning process, many countries have established Emergency Operation Centres (EOCs). An EOC is a central command and control facility responsible for carrying out disaster management functions at a strategic level in an emergency situation, and ensuring the continuity of operation of a key government entity.

A critical component of an EOC is its communication system to receive information in a timely manner and disseminate appropriate messages to alert relevant officials and to communicate with the response teams on site. Since the regular telecommunication infrastructure of public wired and wireless telephones is usually destroyed or damaged by the disaster, it is essential to set up robust and reliable systems that will continue to function during disasters. For instance, EOCs can employ both terrestrial and satellite-based communication technologies with redundancies to establish a based network. Interoperability between these technologies must be considered for seamless communication between the primary and back-up platforms.[74] In providing rapid back-up in an emergency, wireless and mobile satellite based units that can be transported to the disaster site can be procured in advance.

There are a number of information systems and communication solutions for response and recovery being developed and continually improved upon. Examples of systems developed in Asia include DUMBO, OpenCARE and Sahana. DUMBO is a project initiated by the Asian Institute of Technology Internet Education and Research Laboratory.[75] It is a set of network technologies deployed post-disaster to provide multimedia communication responders on site and with a distant command headquarter, when a fixed network infrastructure is not available or has been destroyed. OpenCARE[76] is an information middleware that enables incompatible systems to work together. At the same time, it is also an information/alert dissemination system. Its development is being led by Trin Tantsetthi, former president and CEO of Internet Thailand.

Sahana was developed by a group of IT volunteers from Sri Lanka, headed by the Lanka Software Foundation, after the 2004 Indian Ocean Tsunami. Sahana is a web-based disaster management application for tracking missing people and coordinating relief and recovery efforts of different agencies, including the matching of pledges of aid to requests from the field and the management of camps. Sahana was authorized and used by the Centre for National Operation (CNO) as a part of their official portal in 2005. Sahana is a FOSS application, which means all users can use, copy, distribute and modify the software without having to seek permission for a license. This is critical because it enables systems to be modified to specific circumstances or specific disasters quickly, making the system re-usable for the future and open for further development by IT professionals from around the world. Since its first deployment by the CNO in Sri Lanka, Sahana has been further developed by a global community of over 200 volunteers comprised of emergency management practitioners, humanitarian consultants, academics and software developers. Additional features have been added to Sahana to not only assist in relief operations but also to help countries prepare for different type of disasters. New applications include a volunteer coordination system, mobile messaging and situation mapping. Sahana has been deployed in over a dozen other countries, and has gained a tremendous amount of recognition for the project and for the concepts it promotes. It has also received numerous awards. (see case study on Sahana below)

Following Cyclone Nargis in Myanmar, a local NGO, Myanmar Egress, and the Myanmar Computer Professionals Association started a DUMBO-Sahana Project.[77] The project includes training, and the set up and customization of DUMBO, wireless ad-hoc mesh networks, GPS mapping, Sahana and OpenStreetMap to enhance the communication and coordination aspects of Myanmar's emergency response system. A number of recent systems and solutions for response and recovery, including DUMBO and Sahana, are briefly discussed in an article by Nadia Nouali, et al.[78]

When disasters strike, private companies play a significant role in relief efforts, and in rebuilding the economy. Companies in the communications industry in particular, have been known to donate communications equipment, repair the communications infrastructure or provide alternative communications systems in case the infrastructure is damaged. Ericsson implements an Ericsson Response Programme that not only provides communication solutions at times of disasters, but is involved in research and raising awareness. Ericsson also contributed to the development of IFRC's Disaster Management Information System.

The Alcatel-Lucent Foundation, the company's philanthropic arm was actively involved after the Sichuan earthquake. Other companies such as Motorola and Qualcomm have partnered with governments and NGOs in providing emergency communication devices such as satellite phones, and various networking solutions. Engaging in partnerships with private sector at the emergency response planning stage is essential in order to ensure better coordinated response operations during emergencies. Partnerships with private sector to support longer-term mitigation and preparedness activities should also be explored.

The World Food Programme (WFP), rather than rely on borrowing equipment from large corporations, developed its own system to allow relief workers to communicate with field offices and headquarters. WFP is also the service provider for the Emergency Telecommunication Cluster (ETC). The cluster approach aims to strengthen the effectiveness of humanitarian response through building partnerships. It promotes predictability and accountability in international responses to humanitarian emergencies, by clarifying the division of labour among organizations, and better defining their roles and responsibilities within the different sectors of the response.[79] ETC is one of the nine clusters established. It aims to

74. ESCAP, Enhancing Regional Cooperation on Disaster Risk Reduction in Asia and the Pacific: Information Communications and Space Technologies for Disaster Risk Reduction, Note by the secretariat presented at the First Session of the Committee on Disaster Risk Reduction, 25-27 March 2009, Bangkok, Thailand, http://www.unescap.org/idd/events/cdrr-2009/CDR_5E.pdf.
75. See http://www.interlab.ait.ac.th/dumbo/.
76. See http://opencare.inet.co.th/twiki/bin/view/Main/WebHome, http://nationmultimedia.com/option/print.php?newsid=30086500, http://www.bangkokpost.com/221008_Database/22Oct2008_data71.php.
77. Myanmar Egress and MCPA, DUMBO & Sahana Project Implementation Plan, 23 June 2008, http://www.nargisaction.org/images/pdf/reinvent/dumbo__sahana_project_implementation_plan.pdf.
78. Nadia Nouali, et al., "Information Technology for Enhancing Disaster Management," 22 June 2009, http://www.scribd.com/doc/16654082/Using-Information-Technology-for-Enhancing-Disaster-Management.
79. For more information on the cluster approach, see http://ocha.unog.ch/humanitarianreform/Default.aspx?tabid=70.

ensure timely, predictable and effective provision of inter-agency telecommunication services in support of humanitarian operations from the onset of the emergency. WFP has partnered with Vodafone Foundation and United Nations Foundation to set up an ICT Humanitarian Emergency Platform to increase the efficiency and coordination of emergency communication by optimizing and standardizing ICT solutions in emergencies, organizing training programmes on the use of ICTs in disaster preparedness and response to expand the pool of trained ICT experts, establishing a network of stand-by partners ready for deployment, and enabling immediate dispatch of ICT emergency responders.[80]

Evident from the numerous examples given above, ICT applications and solutions are available for almost any situation. But humanitarian organizations can face regulatory barriers that make it extremely difficult to import and rapidly deploy telecommunication equipment for emergency without prior consent of the local authorities. A notable policy breakthrough in emergency communication is the Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations that came into force on 8 January 2005, following ratification by 31 countries.[81]

The Tampere Convention calls on States to facilitate the provision of prompt telecommunication assistance to mitigate the impact of a disaster, and covers both the installation and operation of reliable, flexible telecommunication services. Regulatory barriers that impede the use of telecommunication resources for disasters are waived. These barriers include the licensing requirements to use allocated frequencies, restrictions on the import of telecommunication equipment, as well as limitations on the movement of humanitarian teams.[82]

5. About the Case Studies

Following this introductory chapter, there will be five national case studies from Bangladesh, China, Sri Lanka, and Haiti, and two regional ones that provide in-depth accounts of the processes, challenges, solutions and good practices from their programmes. Focused on different phases of the DRR cycle and the use of a variety of ICT applications, the case studies draw attention to a rich array of lessons learned and recommendations that are summarized in section 6. Before that, a brief overview of the case studies presented in this publication is given below.

i The Bangladesh Comprehensive Disaster Management Programme (CDMP) is a long-term multi-partner programme designed to institutionalize DRR, not only in the Ministry of Food and Disaster Management, but more broadly across various sector ministries. The programme focuses primarily on strengthening institutional and professional capacities to reduce disaster risks. The case study explores its ICT for DRR initiatives, as well as ways in which ICTs have been used to enhance CDMP's effectiveness.

ii. Another case study on Bangladesh contributed by the Asian Institute of Technology assesses the state of the national emergency communication networks, and proposes an integrated and comprehensive information and communication system to address the gaps and weaknesses of the existing system. The development of the integrated information and communication system is based on the principles of reliability, interoperability, energy efficiency and scalability to meet diverse needs in emergency response.

iii. China, being one of the leaders in the research and use of space-based technologies for DRR in Asia and the Pacific, has shared a case study that discusses the application of space-based technologies to reduce flood risks at different phases of the DRR cycle in China. It also provides an overview of China's disaster management system.

iv. The case study from Sri Lanka looks at some of the bottom-up approaches to ICT for DRR. This study on the establishment of CTEC in Peraliya after the 2004 Indian Ocean Tsunami and their strategies and interventions in bridging the 'last mile' of the EWS is contributed by the Asian Disaster Preparedness Center. The case study also shares some insights into factors that have contributed to CTEC's success and sustainability.

v. The case study from Haiti, highlights the deployment of Sahana applications in the aftermath of the devastating January, 2010, earthquake. Tracing the origins of this Humanitarian Foss system from the 2004 Indian Ocean Tsunami, this study examines how Sahana has since developed and how it is being applied to assist relief and recovery agencies in Haiti.

vi. The UNDP case study is based on a regional programme that supports the establishment of national disaster loss databases in the Tsunami-affected countries. It demonstrates the key factors to the successful implementation and institutionalization of the national disaster loss databases, and at the same time identifies the challenges faced during their implementation.

vii. The final case study gives a detailed insider's account of the evolution of the SEA-EAT blog that was launched within hours of the Tsunami. The case study captured the dynamics of how a group of volunteers from across the globe converged on an online platform, and collaborated in meeting needs for information and coordination during the response phase. This blog site pioneered a model for successful online collaboration for DRR and demonstrated the power of the Internet in saving lives.

80. See http://ictemergency.wfp.org/home and http://www.wfp.org/emergencies/ict.
81. The Tampere Convention was ratified by Pakistan on 1 March, 2009, bringing a total of 40 parties on board. For the full list of signatories, see http://www.itu.int/ITU-D/emergencytelecoms/List%20of%20Tampere%20signatories.doc.
82. http://www.itu.int/ITU-D/emergencytelecoms/tampere.html. For the Tampere Convention, see http://www.itu.int/ITU-D/emergencytelecoms/doc/tampere/S-CONF-ICET-2001-PDF-M07.pdf.

No.	Case Study	Location	Hazard Type	Disaster Management Phase	Type of ICT Application
1	Use of ICT in the Comprehensive Disaster Management Programme in Bangladesh	Bangladesh	Multi-Hazard	Mitigation and Preparedness	Various
2	Integrated Information and Communication System for Disaster Management in Bangladesh	Bangladesh	Multi-Hazard	Preparedness (Emergency Communication)	Various
3	Use of Space-based Technology in China	China	Flood	All Phases	Space-based Technology (GIS and Remote Sensing)
4	Community-Based Early Warning System in Sri Lanka	Sri Lanka	Tsunami and other hazards	Preparedness (Early Warning)	Various
5	The Sahana Free and Open Source Disaster Management System in Haiti	Haiti, Sri Lanka	Multi-Hazard	Response and Recovery	Various
6	Establishment of Disaster Loss Database in Tsunami Affected Countries	India (Tamil Nadu), Indonesia, Maldives, Sri Lanka and Thailand	Multi-hazard	Mitigation	Web-based Disaster Loss Database Application (DesInventar)
7	South-East Asia Earthquake and Tsunami Blog	Regional	Tsunami	Response and Recovery	Various social media

Table 3. Summary of case studies

6. Key Lessons Learned

The case studies and the analysis of ICT for DRR applications and projects in general, reveal a number of key lessons learned that are presented and discussed below.

i. Incorporating ICT for DRR as part of sustainable development efforts

It is widely accepted that some groups in society can be exposed to greater risks because of social or economic inequalities that create more vulnerable everyday living conditions. Because of this, DRR has become increasingly associated with practices that define efforts to achieve sustainable development. ICT for DRR policies and measures, therefore, need to be implemented to reduce the level of risk in communities, while ensuring that interventions do not increase people's vulnerability to hazards.

ii. Providing an enabling policy environment

National governments play a vital role in providing an enabling environment for leveraging the potential of ICT in DRR through appropriate policies and institutional arrangements. Policies need to be in place to promote DRR measures, enhance ICT accessibility, and bridge the fields of ICT and DRR by ensuring cooperation between the two fields in developing innovative solutions that build disaster resilience. Policies to ensure interoperability and compliance with ICT standards are also crucial.

iii. Communicating with at-risk communities

Greater emphasis and priority needs to be given to the communication with people affected by disaster at all phases of DRR. Not only will this lead to more effective outcomes, but more importantly, by giving vulnerable people the right information, they can take greater control of their own lives. Instead of imposing definitions and solutions on people considered vulnerable, their perception and knowledge of risk, and existing coping strategies should be discussed. ICT for DRR interventions should focus on strengthening capacities to address any gaps and challenges that communities have identified themselves.

iv. Introducing appropriate technologies

ICTs should never be imposed on DRR initiatives, especially without an adequate assessment of needs and ICT readiness or how ready a community or nation is in taking advantage of the opportunities provided by advances in ICTs. This includes an assessment of the level of development, access to infrastructure and skills level. A mix of technology and a combination of technological and non-technological solutions may be required. The appropriate mix of information and communication channels will need to be determined by the stakeholders themselves, including the vulnerable communities, through a participatory process.

v. Advancing ICT accessibility

Increasing ICT accessibility - towards universal access to ICT services - will require favourable policies and regulations that may need to be supported with resources dedicated to reaching users located in un- and under-served areas. While expanding the ICT infrastructure, their resilience to disasters should also be considered, incorporating back up services, and diverse and redundant communication channels.

vi. Advancing information accessibility

There is currently abundant information available globally on DRR, but that does not necessarily translate into its widespread availability or utility. Information accessibility may be limited by different forms of discrimination and marginalization due to gender, disability, literacy, age, religion, race, caste, etc. The Web Content Accessibility Guidelines is an attempt to make web content more accessible to people with disabilities. These guidelines also make Web content more usable by older individuals with changing abilities due to aging and often improve usability for users in general.[83] It is also important to ensure that content is well targeted for the users. In many places and cultures there is little relevant information conveyed in local languages or suited to the actual living conditions of people exposed to natural hazards. Language barriers must also be overcome for existing information to be accessible.

vii. Creating locally available statistical and analytical skills

The data and information needed for DRR come from a wide variety of sources that are often not

83. See http://www.w3.org/TR/WCAG20/.

shared or integrated in a way that facilitates timely and accurate decision-making in a disaster situation. This is further complicated by the differences in standards used for data collection, recording and storage, creating difficulties when users attempt to access and analyse data. Some countries lack historical records of hazards and the quality of the data may vary. Frequently, historical data is not available in an electronic format, and it lacks proper classification and descriptive information, which makes it difficult to compare data. It is important to build capacities for national data collection with guidelines established for collecting data that are needed for risk assessments, hazard monitoring and disaster forecasting. Data should be appropriately classified and made widely available electronically for use by national and international stakeholders. Limitations remain due to the lack of internationally standardized collection methodologies and definitions, but initiatives such as DesInventar and EM-DAT are working toward developing such standards.

viii. Ensuring Interoperability

Interoperability refers to the ability of two or more diverse ICT systems to seamlessly exchange information and use the information that has been exchanged. Interoperability leads to better decision-making as it allow data compiled by different agencies to be used together to make better decisions, without having to provide additional human and financial resources to convert and compare data. Interoperability also allows for better coordination and trans-boundary cooperation of DRR programmes since information will be easier to obtain.

GDACS that provides near real-time alerts about natural disasters around the world and tools to facilitate response coordination promotes the use of standards for information and communication such as the the eXtensible Markup Language (XML) format for communication and the GLobal IDEntifier (GLIDE) number, a content standard, as a means to achieve interoperability of DRR models and systems. Another noteworthy initiative is the Global Spatial Data Infrastructure Association that encourages the collection, processing, archiving, integration and sharing of geospatial data and information using common standards and interoperable systems and techniques.

ix. Encouraging standardization

A standard is "a framework of specifications that has been approved by a recognized organization or is generally accepted and widely used throughout by the industry."[84] Standardization is important for the way data is collected, stored and used, allowing the same set of data to be displayed in multiple ways. Standardization is also required for the way in which the data is communicated, as a means for information exchange and collaboration. Standards reduce training, and system and data conversion costs; and ensure that the next purchase of software and systems is not dictated by the last purchase, thus increasing choices to information and services.

Using standardized ways of communicating decreases the likelihood of non-compatibility of systems and of misunderstanding, which are both essential in crisis situations. The Common Alerting Protocol, which is based on XML, standardizes the content of alerting messages. The Emergency Data

84. Nah Soo Hoe, FOSS: Open Standards, Bangkok: UNDP Asia-Pacific Development Information Programme e-Primers on Free/Open Source Software, 2006, p. 1, http://www.iosn.net/open-standards/foss-open-standards-primer/foss-openstds-withcover.pdf.

Exchange Language is a broad initiative to create an integrated framework for a wide range of emergency data exchange standards to support operations, logistics, planning and finance. The GLIDE number creates unique identification of disasters, preventing confusion as to which disaster is being referred.

x. Supporting free and open source software and open standards

FOSS is software that can be used, copied, studied, modified, and redistributed without restriction. These freedoms that are for all - developers and users - are highly significant to DRR as FOSS allows immediate access, ownership, and control of ICTs. It provides a framework for the usage and sharing of intellectual capital, and allows customization to meet diverse cultural and development needs.

Most FOSS embraces a community-style software development model which is based on collaborative development of the software amongst interested parties, usually worldwide over the Internet. While there is normally a core group of developers who oversee and steer the software development effort, anyone who has an interest and the necessary skills can contribute towards the software. This opportunity, along with the source code availability and freedoms guaranteed by FOSS licenses, encourages the sharing of FOSS and their customizations, and makes available a wide community in which to address any problems encountered.

Open ICT standards are becoming increasingly important as no single technology, group or vendor can provide all the solutions. Standards that are open and non-discriminatory are preferred because there is no dependence on any single entity. All types of products can implement them and all interested parties can partake in their development. The Internet is a great example as its foundation is open standards software such as TCP/IP and HTTP.

xi. Incorporating gender dimensions in ICT for DRR

There are limited studies on gender relations in the use of ICT for DRR. But in general, women do not have as much access to information and ICTs as men. Information tends to pass through male-dominated government agencies of disaster management, meteorology and agriculture. Women also tend to suffer disproportionately when disasters strike. In some regions the 2004 Indian Ocean Tsunami claimed the lives of four times as many women as men.[85] And gender stereotypes in relief aid continue to exist, as evidenced after the Tsunami when mobile phones were distributed to men's self-help groups but not to women's groups because technology was perceived as a man's concern.[86] Women's lack of privacy and security, and exposure to gender-based violence in temporary shelters are regularly cited as serious concerns. According to the Gender and ICT e-Primer,[87] women are more inclined towards ICTs that are more audio in nature, such as the radio and even the mobile telephone. This is because the level of literacy among women is generally lower and audio ICTs allow women to multi-task, e.g. listen to radio while doing their work. Planning and implementation through all phases of DRR need to be gender-sensitive. The selection of ICTs and the crafting of messages for early

85. BBC News, "Most tsunami dead female - Oxfam," 26 March 2005, http://news.bbc.co.uk/2/hi/south_asia/4383573.stm.
86. Tsunami Global Lessons Learned Project, op. cit.
87. Angela M. Kuga Thas, Chat Garcia Ramilo and Cheekay Cinco, Gender and ICT, Bangkok: UNDP Asia-Pacific Development Information Programme e-Primers for the Information Economy, Society and Polity, 2007, http://www.apdip.net/publications/iespprimers/eprimer-gender.pdf.

warning as well as for public awareness campaigns must also be gender sensitive. Women's knowledge needs to be valued and their voices should be heard. Women need to be empowered to build resilience and protect themselves from disasters, and they need to be engaged in decision-making processes. There is also an urgent need for gender-disaggregated data.

xii. Sustaining efforts

ICT tools and systems acquired must be sustainable and regularly used. Local capacity to maintain and repair these systems is also critical so that the system is functional and ready when it is needed. ICT tools such as computers can also be used for other development interventions. For example CTEC, a community early warning centre, is planning to hold regular computer training for school children.

The use of established channels of communication such as a popular community radio programme to promote DRR contributes to its sustainability. It's also more cost-effective.

Successful telecentres can also extend their services to play key roles in providing disaster information and be a part of the EWS in alerting communities of impending hazards. The role of telecentres in raising DRR awareness and imparting DRR training, as well as their role as command centres during emergency response, should be explored.[88]

Regular tests of ICT systems, particularly those established for infrequent disasters, should be organized not only to ensure that the systems continue to function properly, but also to test the processes and procedures established in using these tools and systems for early warning or other purposes.

xiii. Promoting public-private partnerships

Public-private partnerships can help to share costs and ensure sustainability of system. The rich human, technical and material resources of private companies particularly in the communications industry should be tapped, and dialogue with these companies should begin in the preparedness and response planning stage. The report by LIRNEasia for the Maldives, for example, examined not only the use of cell broadcasting for public warning but also for commercial use - for news alerts, traffic notifications, service announcements, advertising, tourist information, and more.

xiv. Building capacities

Supporting the development of a cadre of people with expertise in both disaster management and ICT increases the likelihood of developing effective ICT for DRR applications. This requires training disaster managers in IT skills that go beyond those of a general user, and to train a group of IT workers (e.g., database and system administrators and application developers) to have domain expertise in DRR. Mechanisms include: training activities that invites both ICT and DRR experts, providing opportunities to initiate dialogue; field tests and field work conducted jointly by ICT researchers and disaster management practitioners; and combined disaster management-ICT expert teams that jointly analyses the performance of processes and systems after a disaster.

88. See ESCAP, Using telecentres for disaster risk management at the community level, Policy Brief on ICT Applications in the Knowledge Economy, Issue No. 5, September 2009, http://www.unescap.org/IDD/pubs/Policy_Brief_No.5_camera-ready.pdf.

xv. Giving priority to regional efforts

As most disaster events cross national boundaries, it is essential for national governments to invest in regional efforts. Regional and international organizations serve as critical allies by sharing knowledge and creating a common platform that national governments can harness.

One of the mechanisms for regional cooperation is the ASEAN Agreement on Disaster Management and Emergency Response (AADMER), which entered into effect on 24 December 2009 after being ratified by all the ten Member States of ASEAN. AADMER is a legally-binding agreement to promote regional cooperation and collaboration in reducing disaster losses and conducting joint emergency responses in the ASEAN region. In the context of AAMER, the ASEAN Committee on Disaster Management will be addressing gaps in DRR strategies, programmes and activities at the regional and national levels; facilitating linkages between regional and national programmes and other activities supporting the achievement of the HFA; promoting multi-stakeholder participation; mobilizing support to national disaster management organizations for the development and implementation of Strategic National Action Plans for DRR; strengthening regional technical training and capacity development programme in the areas of priority concern of the Member States; and improving access to knowledge and information on DRR issues. ICTs are essential tools for all these activities.

7. Conclusion

The Asia Pacific region is fast becoming the hub of global production and consumption. Dramatic economic growth has enabled a reduction in poverty and social progress in many parts of the region, and significant progress has been made in achieving millennium development targets. Disaster impacts, however, threaten to undermine these achievements.

At the same time, the accessibility and affordability of numerous ICT tools are growing at exponential rates in the Asia Pacific region, and policymakers can no longer ignore the use and benefits that ICTs can bring to reduce disaster risks in innovative ways.

ICTs have become essential to the effective management of all phases of the DRR cycle, and are widely used for: 1) collecting data and information in databases to manage logistics during emergencies as well as for modeling and forecasting; 2) developing knowledge and decision support tools for early warning, mitigation and response planning; 3) sharing information, promoting cooperation, and providing channels for open dialogue and information exchange; and 4) communicating and disseminating information, particularly to remote at-risk communities.

The advancement of ICTs has made DRR easier, but procuring the technology alone is insufficient - it requires a mix of political, cultural and institutional interventions, and coordination between governments, corporate sector, civil society, academia, media agencies and volunteers. ICT for DRR initiatives are more about people and processes than about the technologies. It is important to identify needs, gaps and capacities and assess which technologies will help meet a project's objectives, or one may find at a point in time that ICTs are not required to effect change and achieve goals. There is growing recognition on the need for a culture of communication that values proper information management and inclusive information sharing. Thus, the presence of essential ingredients for successful programming such as strong leadership, political commitment, multi-stakeholder participation, and capacitated human resource pools, are fundamental to the success of ICT for DRR interventions.

The latest World Disasters Report on early warning and early action caution that advances in ICT and the widespread access to the global media means a breakdown in control and potential confusion among target groups.[89] Therefore the importance of public education in disaster preparedness cannot be emphasized enough. It is also vital to incorporate in formal and non-formal education systems, the competencies to search, organize and analyse information, engage in critical thinking, and judge the intention, content and possible effects of the information. With strengthened capacity and increased knowledge on disaster preparedness, individuals and communities as groups can sift through the multitude of information and make appropriate decisions on the action to take.

ICTs are tools that when used effectively can enhance and accelerate DRR, but they rely on the actions of individuals and organizations in order to be fully effective. Without visionary policymakers and other ICT-capable government officials, opportunities presented by ICTs in reducing disaster risks are unlikely to be recognized and applied. Capacity building in this area is therefore critical.

APCICT, committed to building ICT capacity for social and economic development, is developing a training module on ICT for DRR based on demands from Member States. Demand for capacity building in the area of ICT for DRR has been requested at several forums including the ESCAP-organized Expert Group Meeting on WSIS+5 and Emerging Issues in Asia and the Pacific held on 18-19 November 2008 in Bangkok, Thailand, ESCAP's First Session of the Committee on ICT on 19-21 November 2008, and ESCAP's First Session of the Committee on DRR on 25-27 March 2009.
The training module will be part of the Academy of ICT Essentials for Government Leaders, a flagship programme of APCICT that includes a comprehensive ICT for development curriculum and over a dozen partners that are working with APCICT to roll out the Academy at the national level. Academy workshops have been held throughout Asia and the Pacific in Afghanistan, Cook Islands, Indonesia, Kiribati, Kyrgyzstan, Mongolia, Myanmar, the Philippines, Republic of Korea, Samoa, Tajikistan, Timor-Leste, Tonga and Tuvalu.

89. IFRC op. cit., page 28.

Case Studies

1. The Bangladesh Comprehensive Disaster Management Programme and ICTs
2. Integrated Information and Communication System for Emergency Management in Bangladesh
3. Space Technology Application for Disaster Management in China
4. Reaching the Last Mile through Community-based Disaster Risk Management: A Case Study from Sri Lanka
5. The Sahana Free and Open Source Disaster Management System in Haiti
6. Establishing and Institutionalizing Disaster Loss Databases: Experience from UNDP
7. SEA-EAT Blog

The Sahana Free and Open Source Disaster Management System in Haiti

Chamindra de Silva and Mark Prustalis

1. Introduction

In the afternoon of 12 January 2010, a 7.0 magnitude earthquake struck the poverty-stricken Caribbean nation of Haiti. The impact of the earthquake, occurring just south of the densely populated capital city of Port-au-Prince, was devastating as scores of multi-storied concrete structures in the capital and surrounding municipalities collapsed, killing tens of thousands instantly, injuring and trapping thousands of others beneath the rubble.

The earthquake struck mere weeks after the five year anniversary of the Indian Ocean Tsunami. Haiti also represents the first time since the Tsunami that the international community has been called upon to respond to a disaster of such magnitude with a lifesaving search and rescue and emergency relief effort under the coordination of the United Nations and foreign governments. The use of Sahana Free and Open Source Disaster Management System (Sahana) in the Haiti relief effort is only fitting as the system grew out of the devastation leveled by the Tsunami. Haiti, and Sahana's application in the relief effort, represents another instance of what the international community has learned since the Tsunami in terms of humanitarian response, and how it has applied such lessons to disaster relief and management.

This Case Study examines the development of Sahana that grew out of the devastation of the Tsunami in Sri Lanka, and has evolved to serve and support a variety of ICT related needs of the disaster response and relief operations in Haiti. Sahana and its community of dedicated contributors illustrate the potential and lifesaving power of effective and coordinated ICT use in disaster relief and management operations.

2. Sahana Genesis and Vision

The Sahana Free and Open Source Disaster Management System (Sahana) was conceived during the December 2004 Indian Ocean Tsunami in Sri Lanka. It was developed by volunteers from the ICT industry in Sri Lanka to help manage the scale of the disaster, and was deployed by the Sri Lankan government to help coordinate its relief efforts. The initial system helped to track families and coordinate work among relief organizations during and after the disaster. Based on the success of this initial application and the lack of good large scale disaster management solutions, a second phase was funded to make the project a global public good by utilizing Free and Open Source Software (FOSS) in conjunction with humanitarian response operations. Humanitarian FOSS (H-FOSS) was the result these efforts.

Box 1. Sahana H-FOSS

Humanitarian FOSS (H-FOSS) is the application of Free and Open Source Software in the support of humanitarian response. In conceptualizing Humanitarian-FOSS (H-FOSS), the Sahana community references the Red Cross and its Code of Conduct[119].

- No Access Discrimination : FOSS eliminates delays in getting permission for a license as anyone has the freedom to download and use the software. Once available under a FOSS license, the software effectively becomes a global public good, available for anyone from around the world
- Trust and Transparency : The software design and mechanism for building FOSS is transparent, thus building trust. Additionally, with truly global and diverse FOSS communities, the software becomes resistant to any particular political agenda.
- Low Cost and Local Capacity : Few countries, whether rich or poor invest significant resources in pre-disaster management, because there are always higher priorities that need funding. H-FOSS helps reduce the digital divide as there is no additional cost for the product itself. Though people are still needed to maintain the software. a nation has the freedom to reduce costs by promoting the type of local capacity development encouraged by FOSS communities.
- Shared Inter-Organizational Development : NGOs and humanitarian relief groups all need software tools to be effective; however, not all have the funds to purchase the needed tools. H-FOSS projects can be developed and shared globally when a disaster strikes. The FOSS community has a proven track record to build, distribute and maintain such global systems. FOSS can easily provide a vehicle by which organizations can contribute a fraction of the resources, yet benefit from the whole.
- Adaptability : No two disasters are alike; often localizations and customizations are needed for the software before it can be applied effectively to a disaster. Furthermore, no two nations handle the humanitarian response in the same manner. Thus, there are many variances expected of software, including translation, before it can be used by different nations. With FOSS and its blueprints so freely available, anyone is able to modify the software as required to suit a nation's disaster needs.

119. http://www.ifrc.org/publicat/conduct/).

The second phase of Sahana was funded by the Swedish International Development Cooperation Agency (SIDA) and run by the Sri Lanka Software Foundation. The funds supported a core team of 6 full time people that built a more generic disaster management platform, and worked with the growing number of volunteers that joined the Sahana community during subsequent disasters and use of Sahana applications. Today, the Sahana community includes over thirty active individuals supplemented by over hundred members and organizations that further disaster response research and development.

2.1 Disaster Coordination and Information Needs

The vision of Sahana is to help alleviate human suffering and help save lives through the effective use of ICT to help manage disaster coordination problems during a disaster. During its development, Shana identified scale as the primary cause of coordination problems. Large scale disasters affect a million or more people within a very short span of time, and wipe out transport, communications and local emergency management infrastructure such as policing forces, hospitals or fire brigades. Even if infrastructure is left intact, the scale of the disaster can still greatly overwhelm the local resources available to handle those emergencies. To effectively handle the scale of the situation, therefore, the response needs to be quickly supplemented with foreign and local donations, support from civil society, and often the very victims acting as first-responders. Though support is often forth coming, coordinating chaos ensures because each relief group on scene has little idea what the other is actually doing. As a result there is a waste of pledged support, imbalances in aid distribution and a lack of proper coverage of support and services.

Obtaining the right information in these scenarios is critical in preventing chaos and in order to alleviate human suffering and save lives. The right information can provide relief and support to a host of effected peoples; from a crying mother desperately searching for news about her missing child, to camp personnel waiting for the right medical supplies to treat victims; and relief coordinators trying to distribute resources to the right place and in the right quantity. However, managing information is also crucial as large scale disaster relief involves hundreds of humanitarian agencies and organizations that in turn generate massive amounts of data. That is where ICT helps manage information. Through ICT the right data can be shared and accessed instantaneously by government, field operatives, civil society groups, victims and the victims' friends and relatives to enhance the relief effort. If used properly, ICT managed data will empower these stakeholders to build off each other's work. Governments, especially in developed nations, often have 'in-house' systems that manage the tracking of people during disasters. These systems and the data they contain, however, are often protected by privacy regulations that prevent access by relief groups and volunteers that want to help. Furthermore, government operated relief infrastructure can sometimes get in the way due to inadequate resources on the ground, which can then prevent independent relief groups and volunteers from directly and immediately helping the victims.

Clearly then, the right information needs to be both shared and well managed to allow all relief entities to coordinate and operate as one, and effectively distribute aid and services. A centralized portal for government and relief groups would provide a lot of value, if it were not so inflexible to allow for customization necessary in unique disaster environments. Sahana, however, is flexible and does not dictate a portal approach, though it can be deployed as one if required. Sahana's strength lies in its Open Source nature and its ability to be downloaded and customized by anyone to work with specific countries, organizations and purposes. Many governments welcome this approach as it allows them to maintain ownership and control over the system and the data.

3. The Sahana Platform

In order to face the challenges created by large scale disaster and meet the needs of those responding to them, the Sahana platform was designed on principles reflecting an ability to adapt to the constrained environment ICT solutions encounter during a disaster response effort. In addition to the macro-level problems of scale and quantity of data noted about, disaster response initiatives also encountered every day, operational constraints.
The additional ICT related problems that are faced include:

- Telecoms and Internet access is either down, or intermittently available.
- Bandwidth is often at a premium, so every character counts.
- Power outages reduce reliability and availability.
- Potential data center or infrastructure damage due to the disaster.
- Human resources unfamiliar with new systems.
- Off the shelf systems often have to be customized for the requirement or risk not capturing specific aspects of gathered data.
- Local developers have very little time to learn and support the system.
- Interoperating with existing systems and creatiing ad-hoc spreadsheets is often difficult.

When a systems does not address many of these concerns, it was noted that most organizations and volunteers quickly revert to using spreadsheet based systems, which eventually become difficult to clean, match and collate into useful information. However, even if a system is available to address the above, it will not be available to all responders. Thus, one organization will always have to handle the import and export to spreadsheets as part of the solution. Therefore, Sahana was designed by taking such considerations into account.
The principles the Sahana platform was built upon are:

- Bandwidth Efficient : The system has to make efficient use of bandwidth. Thus, the architecture was built so that the developer was quite aware of what his/her module will produce in XHTML or XML on the wire. XHTML without style information is sent back and the entire visual look and feel of the UI is generated entirely from CSS style sheets.

- Quickly Accessible Interface : The system was build to have a clean, uncluttered and simplistic interface which a responder could understand intuitively. Additional help text and tool tips are provided to help familiarize the new user to the system.
- Easily Modifiable : As no two disasters are identical, the system strives to be a rapidly customizable solution. Many of the key customizations (e.g. localization) are available to be done through supporting administrative interfaces. However, if more is needed, the framework's simple design is such that not much more than knowledge of vanilla PHP development is required.
- Framework Components : Features such as GIS, From creation, Security, Language, Tool-tips, translation and reports are built into the Sahana framework, so that a new developer can focus primarily on the business logic.
- Portability and Synchronization : Sahana is also available as a portable application and, thus, moving the program with its data is as simply a matter of copying a directory to a USB disk. If the USB disk is fast enough, the entire program can be run from the disk. When necessary, the data in the portable version can be synchronized with another instance[120] or a central server.
- Ubiquitous Hardware : Though Sahana in using the LAMP stack and can scale up to a server farm to support higher concurrency and throughput, it can also run on low hardware specifications. Therefore, it will run on most existing hardware in developing countries that run XP or above on the server side. Linux is, however, a more efficient way to run Sahana as it supports Ubunutu and Redhat versions on the server
- Resilient Architecture : The architecture adheres to the KISS (Keep it Simple Stupid) principle, which in turn makes the system easy to maintain and reduces the number of potential failure points. Dependencies in the system are kept to a minimum. For example, though internet access is needed to display map tiles, the system degrades gracefully by using alternative GIS to plot points if an internet connection is not available.
- Open Standards Support : Currently, Sahana supports multiple Open Standards from the GIS options such as WFS, WMS, GeoRSS, KML, GML, GPX, to domain specific ones like EDXL-HAVE, CAP and PFIF found in Table 1. Data from these standards can also be exported onto any number of spreadsheet formats[121].

Open Standard	Definition
WMS	The Web Map Service provides georeferenced map images over the Internet that are generated by a map server using data from a GIS database
WFS	The Web Feature Service provides an interface allowing requests for geographical features across the web using platform-independent calls
GeoRSS	Is a standard for encoding geographical location as part of a Web feed
XML	The Extensible Markup Language is a standard for encoding documents electronically, noted for its simplicity and usability over the internet
GML	Geography Markup Language is used to encode geographic content for any application
KML	The Keyhole Markup Language code allows for the visualization of geographic information found on 'Google Earth
GPX	The GPS eXchange Format is an XML schema designed as a common GPS data for software applications
EDXL-HAVE	The Emergency Data Exchange Language is tailored to provide information on hospital availability (Hospital Availability Exchange)
CAP	The Common Alerting Protocol is a data format used for exchanging public warnings and emergencies between ICTs
PFIF	the People Finder Interchange Format is used to provide a cyclical flow of data relating to missing and found persons

Table 1. Sahana Employed Open Standards Definitions

120. An 'instance' refers to a specific deployment of Sahana in either a portable form, or as server
121. Sahana can import data onto the following spreadsheets; JSON, RSS, XML, CSV and XLS

4. Sahana Applications

Sahana and its principled Humanitarian Free and Open Source Software (H-FOSS) approach (see Box 1 for detailed explanation) helps empower a diverse set of actors from Government, Emergency Management, NGOs, INGOs, volunteers and victims allowing them to share and coordinate information on a common platform.

However, Sahana should not be considered one platform, or one simple tool, but rather a rapid application development framework for the rapid creation of solutions for the preparing and relief phase of a disaster. The system supports multiple sub-applications that address the common coordination problems governments and relief agencies encounter in the aftermath of a disaster. Each of these sub-applications exists as independent pluggable modules that can either be included or removed from the final custom solution.

Though the modules presented below were initially conceived during the Indian Ocean Tsunami, and continue to be quite relevant today, many more modules have been contributed by the community. New contributions are often variations of existing modules that have been customized to meet the specific requirements of relief agencies working in unique disaster.

4.1 Sahana Missing Persons Registry

The objective here is to reduce the trauma caused by waiting to be found and to help connect families and acquaintances quickly in order for them to support each other. This type of trauma damage is especially acute for children waiting for loved ones to find them. For example, in Sri Lanka after the Tsunami there were hundreds of bulletin boards with pictures of missing people pinned on them. Physical reviews of hundreds, even thousands of pictures can take quite a while. ICT can help connect people with an online bulletin board to be searched by name, appearance, and age group. Even if the victims or family members do not have access themselves, it is quite easy for any authorized NGO/civil society group to hook up to the central portal and provide that service in the areas that they operate.

The Missing person registry is an online bulletin board of missing and found people. It not only captures information about the people missing and found, but also information of the person seeking missing persons, which adds to the chances of people finding each other. For example, if two members of a family unit are looking for the head of the family, we can use this data to at least connect those two family members. A significant amount of meta data about the individual, such as identity numbers, photos, visual appearance, last seen location, status, can be stored and searched using a 'sounds-like' name search.

4.2 Sahana Organization Registry

During the Tsunami disaster, there was a massive outpouring of support from INGOs, NGOs and the general civil society. In Sri Lanka, there were over three hundred registered NGOs providing support. If all groups are not coordinated effectively, it results in problems such as clogged up supply routes, and uneven distribution of support among within affected areas, double vaccinations and unfulfilled expectations. As a result, all the goodwill and pledged aid will be wasted and under-utilized. However, this can be an overwhelming coordination task for authorized emergency controllers to do manually. An ICT solution can help by providing an organization registry to keep track of who is doing what, where and more importantly where nothing is being done at all (or there is no coverage of a certain service). In this way, aid organizations could self-distribute themselves more evenly across affected regions just by being aware of what other relief groups are doing.

The Organization Registry keeps track of all the relief organizations and civil society groups working in the disaster effected region. It captures not only the places where organizations are active, but also captures information on the range of services they are providing in each area. The module has the ability to obtain public registrations from organizations operating in the region; registering all associated meta data to it and creating a 'who is doing what and where' view of the disaster zone. More importantly is the drill down reporting on the converge of services and support in the region, and the identification of area where no aid services are being provided. The coverage can also be visualized through mapping of relief organizations in the field.

4.3 Sahana Request Management System and Inventory

In the immediate aftermath of the Tsunami there was an unprecedented response in terms of aid and supplies; however 8 months after the Tsunami many of those pledges of aid were not utilized. The main reason for this was a lack of awareness and visibility to the aid available between those that require aid to those that can provide it. For example, while only one NGO might get a specific request for aid, probably only one out of a hundred will actually have a supply of that aid item. It would be impractical for this NGO to check with hundreds of potential places to see if that item is available. Instead, what we need is a well structured central repository of aid being pledged and a system tracking requests for aid. An ICT system should additionally help by intelligently matching requests and aid items.

The Sahana request management system is a central online repository where all relief organizations, relief workers, government agencies and camps can effectively match requests of aid and supplies to pledges of support. It essenyially looks like an online aid trading system that tracks requests through to fulfillment. The inventory system, in turn, is a simple logical system to track the storage and distribution of aid between the time a pledge is delivered to a warehouse to its final distribution among recipients. Its preset categorizations are based on the WHO catalog for the classification of items, which also tracks expiry dates and re-order levels for certain items in the inventory.

4.4 Sahana Volunteer Management System

There is often a massive outpouring of volunteer support during a disaster, as motivated people contribute their skills in support of the relief efforts. Volunteers come from a variety of professional backgrounds including medical practitioners, engineers, logistics management professionals, drivers or generic spontaneous volunteers looking to help out. This presents a vast resource that if tapped effectively can provide a massive impact to the relief effort. However, the personnel numbers to be managed can be in the tens of thousands. Thus, a system is needed to track the individuals, their skills/professions, their availability and what projects they are currently working on. The Volunteer Management module also has a self-registration system that permits the scalable entry of all the volunteer data and search a system that allows for a database search of volunteers for a particular project.

4.5 Situation Mapping System

Mapping and GIS are important features for the effective visualization of a disaster, and for preparing an effective response. Sahana supports Open Layers, which permits Sahana to get any map tile or feature layer that supports the common GIS Open Standards such as WFS, WMS, GeoRSS, KML, GML, and GPX to name a few. This is important because most of the Sahana's modules, including the organization and shelter registries, geolocate their entries as part of their workflow, which can in turn be seen on the central map. The mapping functionality is essentially a core part of the Sahana framework and is accessible to be utilized by any module that needs to enter points or display custom maps.

4.6 Displaced Victim Registry

In contrast to the missing person registry, the displaced victim registry is about tracking displaced families or groups by their composition. One does not have to enter all family members, but you need a brief break down of the number of babies, children, adult males/females and elderly in the displaced family and brief details of the head of the group. Their location is attached to a camp, organization or generic GIS coordinate. This data is used to track families and estimate the amount and type of aid to be distributed.

4.7 Shelter Registry

The Shelter Register is a simple system to plot the location of temporary and permanent shelters for victims, illustrating the main concentration points of shelters after a disaster. Shelter data includes numbers and capacity, so that organizations are aware when a shelter is reaching full capacity or when it is not being fully utilized.

5. Documented Shana Deployments

Since its inception, Sahana has achieved much in delivering value to disaster management efforts, and its vision and applications have been utilized in countries throughout the world, building a community inspired by and dedicated to relief through the use of H-FOSS. By the very nature of being a free and open source project that is available to download from popular public repositories without notification, it is difficult to determine exactly where Sahana has been used, customized and by whom. Nevertheless, the many instances of Sahana application customizations with little contact to and support from the Sahana community is a testament to Sahana's simplicity and functionality.

The deployments noted in Table 2, however, were instances when the Sahana community were actively involved in the deployment and thus, more aware of its ability to delivery. In most cases, deployments were government led and front-ended by an influential local group[122]. In the case of the New York City deployment, Sahana was implemented as a pre-disaster component of the City's Costal Storm Plan.

Year	Disaster	Location	Partner(s)
2005	Tsunami	Sri Lanka	CNO, Government of Sri Lanka
2005	Asian Quake	Pakistan	NADRA, Government of Pakistan
2005	Southern Leyte Mudslide	Philippines	NDCC and ODC, Government of Philippines
2006	Sri Lanka Disaster Preparedness	Sri Lanka	Sarvodaya - Sri Lanka's largest NGO
2006	Sri Lankan Civil War	Sri Lanka	Terre des Hommes
2006	Yogjarkata Earthquake	Indonesia	ACS, urRemote, Indonesian Whitewater Association, Indonesian Rescue Source
2007/08	Pre-deployment	New York City	Costal Storm Plan
2007	Ica Earthquake	Peru	Government of Peru
2008	Shizuan Earthquake	Chengdu	Chengdu Police
2010	Haiti Earthquake	Haiti	WFP, InSTEDD, U.S. State Department, Ushahidi, Sahana Foundation

Table 2. Documented Sahana Deployments and Users

122. IBM has been a strong partner in this regard, with its local IBM country offices taking the lead. Through the country offices the IBM Foundation often recommend and donate Sahana help with hardware to the government.

6. Sahana in Haiti

The Sahana Software Foundation and the Sahana community responded with a massive voluntary effort immediately following the earthquake in Haiti. Working around the clock, members of the Sahana community set up a hosted instance of Sahana (the first post-disaster deployment of Sahana's python-language[123] version - SahanaPy) on a public website that served to fill gaps in the information management requirements of the massive relief operation. This hosting utilized for the first time SahanaPy, Sahana's first version of the popular python programming language. Sahana's response culminated in the launch of The Sahana Haiti 2010 Earthquake Disaster Response Portal, a live and active website that provided responder with access to all of Sahana's modules[124]. Documented below is a discussion of the some of the most utilized modules, why they were utilized by responders, and what results they achieved.

6.1 Core Applications

In the first 48 hours after the earthquake, what responders wanted to know was who else was responding, what organizations already had staff in Haiti, where were they located, and what assets and resources did they have available to them. Sahana's Organization Registry (OR), served to track organizations and offices working on the ground in Haiti. The OR provided a searchable database of organizations responding to the disaster, the sector where they were providing services, their office locations, activities and their contact details. It became one of the primary repositories of organization, office and contact information for the relief operation during the first couple of weeks of the response. The Sahana team encouraged organizations to self-register by email and report their office locations, and volunteers were organized to assist with data entry and to aggregate lists from many sources. Data from pre-disaster lists of organizations working in Haiti available from the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), as well as active contact lists used by the United Nations Disaster Assessment and Coordination (UNDAC), InterAction and other sources with official and accurate points of contact was entered into Sahana. Next, responders wanted to know where relief and life-saving efforts were most needed. To address this, Sahana provided a simple Request Management System (RMS) to allow requests for assistance (such as "send water") to be made visible to relief organizations working on the ground. Sahana added the capability for organizations to claim requests for fulfillment and later mark them as completed. The RMS

123. Python is a general-purpose high0level program language that emphasizes code readability
124. http://haiti.sahanafoundation.org

also contained a simple ticketing, tracking and reporting system.

The Sahana Software Foundation worked with the U.S. State Department, Ushahidi, Innovative Support To Emergencies Diseases and Disasters (InSTEDD) and others on a project to process SMS messages with requests for assistance and information sent from Haitian citizens. SMS text messages sent to short code 4636 in Haiti were translated from Creole by Haitian volunteers and put into a structured data format identifying the sender's name, location (to the extent possible), and category of the message. The messages were published by a GeoRSS feed from Ushahidi that was captured by Sahana. Sahana could also push updates back to Ushahidi, so that others could see which requests had been responded to. Immediate lifesaving requests were sent from Ushahidi direct to the US Coast Guard and other first responders, while Missing Persons reports went into Google's site that was aggregating missing and found persons data.

The RMS also captured structured messages posted to Twitter using a Hashtag System[125] devised by the Tweak the Tweet project that came out of the Crisis Commons/Crisis Camps community and led by Project Epic at the University of Colorado at Boulder[126]. These messages were also available for review, response and fulfillment within Sahana, although a human filter to separate actionable messages from clutter was needed to make this effective. The RMS was later adapted for use in helping to manage requests for assistance, resources, staff, medical supplies for the Hospital Management System.

During the second week of the relief operation, there were multiple requests to identify the location and operating status of hospitals and medical facilities within Haiti. Sahana organized a volunteer effort to geo-locate approximately one-hundred hospitals with names but without known coordinates over a twenty-four hour period. These efforts added over 160 hospitals to the Sahana registry that had been set up to manage medical and health facility capacity and needs assessment. Sahana's hospital data was published through open standards, making it available to others. A KML feed of the hospital location data remained the most accurate and complete source of operating hospital facilities throughout the first two months of the relief operation, and was accessed by thousands of users world-wide. Sahana also publishes all of its hospital data as GeoRSS, JSON, XML, CSV, GPX, XLS and EDXL-HAVE.

Once immediate lifesaving needs, and health and medical needs for the injured had been addressed, the next challenge faced by relief operations was ongoing support and care for the victims. To address the needs of their food distribution planning, the World Food Programme (WFP) asked the Sahana Software Foundation to adapt its request management system for use by WFP's Implementing Partners made up of relief agencies responsible for distributing food aid to the Haitian population. About one month after the earthquake, the Food Cluster Food Request Portal (FRP) system was available for such use. FTP allows WFP's Implementing Partners to identify their location and the number of beneficiaries they are serving, categorized by age and gender to allow WFP to determine the appropriate types and quantity of food aid needed. The agency also requests a delivery, or agrees to pick up the food

125. A method that allows short messages to be tagged by utilizing the hash symbol '#'
126. http://epic.cs.colorado.edu/tweak-the-tweet/helping_haiti_tweak_the_twe.html

aid at a WFP warehouse. WFP receives the request and confirms it, then schedules a delivery or pickup and communicates back to the Implementing Partner through an SMS message generated by Sahana. This simple request-based planning tool may end up being used by the World Food Programme and the Food Cluster for its global relief operations. This system was set up on a separate server to better isolate the sensitive and operational data

6.2 Additional Applications

In addition to these core modules notes, the Sahana portal supported supplementary functionality by utilizing various other applications in collaboration with other partners operating in Haiti. These applications include registries that document shelter capacity and up to date, in country responder contact information, mapping portals that track medical facilities and responders, and translation function to allow relief agencies to easily translation between English, French, Spanish and Creole. Furthermore, there were various independent deployments of Sahana, the most prominent involving the National Library of Medicine.

The two Sahana supported registries include the Persons Registry (PR) and the Shelter Registry (SR). The Persons Registry serves as the main repository of individual contact information for all Sahana registered users and organization staff. It is utilized by all other Sahana registries to store detailed contact information. The Shelter Registry (SR) used data pulled from other sources through open standards for data exchange to identify the locations of the temporary shelters that were spontaneously set up for the thousands rendered homeless by the earthquake. By pulling the data into a registry rather than simply displaying it as a data layer on Sahana's mapping client, it enables Sahana to manage transactional data in conjunction with its other efforts. Essentially, the SR allows agencies to record the population of an encampment, its needs for water, food, and other supplies, and to manage requests to send supplies; a function that cannot be accomplished with a single plotted point on a map. (At the time of publication, this module had been configured for use in Haiti, but in the absence of a specific end-user. request had not yet been enabled).

The Sahana Haiti portal is also able to map geo-referenced data. The data comes from a variety of sources including temporary shelters, food distribution centers, medical facilities and other data management systems and registries. Working with members of the OSGeo community Sahana has obtained a fast tiled set of the current imagery being made available by Digital Globe[127]. Sahana is also leveraging the constantly updated set of Open Street Map tiles. Other data sources that are being utilized within the system include informational feeds from Ushahidi, various point layers and updated road overlays from Open Street Maps, location names, USGS earthquakes, and locations from GeoNames. Sahana continued to build upon these capabilities as relevant layers were made available to the Haiti relief operation. The Sahana Situation Mapping module is the culmination of these efforts and provides an integrated annotated map of what is happening in Haiti. Sources of data for Situation Mapping are noted in Table 3.

127. http://www.digitalglobe.com/

Base Layers	Lead Agency
Open Street Maps current Haiti maps project (3 options for graphic style and amount of detail)	Sahana Registry (OR, HMS (including 4636 messages), RMS, FRP, SR)
Digital Globe Hi-Resolution Imagery (2010-1-14)	Ushahidi (haiti.ushahidi.com) Events
Ikonos Imagery (2010-1-15, 2010-1-17)	Open Street Maps as an overlay to be displayed over imagery
Google Maps (Terrain, Hybrid, Satellite)	Open Street Maps Points of Interest
1:12.5k Topo Maps for PaP	Other Sahana Locations data
1:50k Top Maps	

Table 3. Situation Mapping data sources

With regard to independent deployment, the National Library of Medicine (NLM), the world's largest medical library and an arm of the National Institutes of Health (NIH), released a version of t Sahana-based "Lost Person Finder", called "Haiti Earthquake Person Locator" HEPL[128]. The site provides an interactive website that provides information about people who have been found in Haiti, or who are still missing. The NLM also developed a specialized "Found in Haiti" iPhone application to geolocate found persons and display it on the site. The HEPL system shares information with other person finder systems using the PFIF standard, including Google's Person Finder, to ensure that all searches operate across the largest possible set of matches. It basically provides a public viewer for Google records (using an interactive Notification Wall), with filters for metadata beyond name, and a supplementary iPhone- or email-based input method (with forwarding to Google so the master registry is maintained).

7. Open Standards for Data Exchange

Sahana's use and promotion of Open Standards for Data Exchange played an important role in Sahana's successful response to the Haitian earthquake, and also had a positive impact on many other efforts and projects. Sahana's REST Controller allows data to be published in numerous standard, common formats including kml, json, georss, gpx, xml, xls, and cs. However, the value of Open Standards was, in particular, noted through the use of EDXL-HAVE and PFIF formats in a hospital management system and missing persons registry respectfully.

For the Missing Persons and Disaster Victim Identification (DVI) registries, Sahana worked closely with Google, Yahoo and others to ensure that a common standard for the exchange of Missing Persons data was implemented using the PFIF (Person Finder Interchange Format) standard. The Google site, (http://haiticrisis.appspot.com/) in turn became the main aggregator for collecting all Missing and Found Persons reports. Sahana embedded Google's widget on the Sahana site for collecting missing person information. While Sahana never established a Missing Persons registry, or its own Disaster Victim Identification registry Shana's participation in producing an agreement on a common standard for the exchange of such data was crucial. Furthermore, Building PFIF compliance into Sahana means that the registry is there to more quickly deploy next time. By importing missing and found persons data into Sahana, others can better manage that data, and utilize data found in the Disaster Victim Identification registry to identify track, trace and handle the bodies of the deceased. Through the Sahana and Google agreement on an open standard for data exchange, any updated missing persons status information that Sahana can provide can also be pushed back to the main Google repository, or another repository that can accept and process PFIF.

However, the real success story in terms of the Sahana Software Foundation and open standards in Haiti concerns the adoption of the EDXL-HAVE standard by the Pan American Health Organization, the American government and responding agencies and technology providers such as Sahana, Google and others involved in collecting hospital data. EDXL-HAVE, or Emergency Data Exchange Language - Hospital Availability Exchange is an XML-based OASIS standard that was designed to meet the type of medical reporting that is necessary in Haiti; specifically, the operational status of a hospital or health facility, its bed availability and resource inventory[129]. Within two weeks of the earthquake, the Sahana portal included a hospital management system that provided an EDXL-HAVE feed. Sahana then worked to extend the use of EDXL-HAVE to other systems working to collect similar data for Haiti, thus ensuring interoperability and the ability to seamlessly exchange data between these systems. In coordination with the PAHO, an EDXL-HAVE based framework is currently being adopted by the Health Cluster for Haiti, and eventually will be handed over to the Haitian Ministry of Health.

8. Conclusion: Recent Lessons Learned

Effective Sahana module deployments in Haiti relief operation further demonstrate the success of open source principles to humanitarian effort. The application and customization of Sahana modules, and their usability

128. http://hepl.nlm.nih.gov/inw/

129. OASIS is a not-for-profit consortium that drives the development, convergence and adoption of open standards for the global information society, http://www.oasis-open.org

and accessibility have had a positive impact on the response to the disaster. However, the application and customization by various organization and agencies in Haiti, and the challenges that this specific disaster faces will allow benefit Sahana and its community through the lessons that will be taught. Indeed, the lessons learned will do much to enhance Sahana and assist it in fulfilling its vision. Though only a short time has passed since the devastating earthquake, the Sahana community has already started to identify lessons and experiences form Haiti that have been incorporated into the way Sahana works.

Preliminary findings include :

- The Sahana community now uses a User Acceptance Testing model on deployment, so that new product versions are well tested before being deployed. With regard to deployment, three instances of Sahana are used and code is propagated from the development version to the UAT version and ultimately to the production instance.
- The use of IRC[130] has been invaluable in coordinating a live response community and also in collaborating with external parties. It is also important, however, to archive IRC chats in order to provide continuing context.
- IRC also has been a fantastic way to recruit new volunteers and to engage them in new efforts. Part of the reason for this is that unlike other systems, no formal subscription / approval is needed to join the IRC Sahana channel and thus, people can easy join a discussion in the passing.
- The CRUD model provided by SahanaPY/Web2Py provides rapid customizing capabilities to Sahana. New fields can rapidly be added to a form with very few data changes.
- Sharing references to data is just as important as sharing information. The REST reference interface in SahanaPy provides simple, transferable references to lists and data records provided that researchers have the right level of clearance to access the data.
- Though the AJAX function provides a lot of added usability, it was an unexpected bandwidth hog and thus, is not recommended in its richest form for disaster management systems.

The Sahana Disaster Management System continues to evolve in order to address coordination needs and to adapt and assimilate new technologies. Haiti was a prime example of multiple Sahana instances being customized and deployed for different purposes. This is a testament to the strength of the H-FOSS model for delivering ICT applications in the field of humanitarian relief. However, as mentioned earlier, an Open Source license is not enough; other aspects of the project need to be in place to make it feasible for rapid customization during disaster response. Open Source communities are not easy to manage as there is a substantial amount of volunteer turnover; however the Sahana project continues to be relevant and used in disaster response. The formation of the new Sahana Foundation should help the project to reach a new height of partnership with the response community and more formal actors from government and the UN. Haiti was an excellent example of such complex partnerships and the importance of open standards in information sharing. Sahana is evolving beyond a simple ICT system to include some of the best practices in the application of ICT for disaster management.

130. Internet Relay Chat is a commonly used online public chat network among Open Source communities.

Establishing and Institutionalizing Disaster Loss Databases: Experience from UNDP[131]

UNDP Regional Programme on Capacity Building for Sustainable Recovery and Risk Reduction

1. Introduction

The United Nations Development Programme (UNDP) Regional Programme on Capacity Building for Sustainable Recovery and Risk Reduction (RP) was established in response to the Indian Ocean Tsunami of 2004. Managed by the Regional Centre in Bangkok's Crisis Prevention and Recovery team, the RP aims to enhance the capacity of Tsunami affected countries in disaster risk reduction (DRR). Its programme activities are in line with the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (HFA).

Risk identification is one of the five priority areas of the HFA as stated: The starting point for reducing disaster risk and for promoting a culture of disaster resilience lies in the knowledge of the hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face, and of the ways in which hazards and vulnerabilities are changing in the short and long term, followed by action taken on the basis of that knowledge.[132]

In addressing this priority, one of RP's strategies is to enhance institutional systems for building risk knowledge through the development of disaster loss databases. At the core of any risk knowledge efforts is the need for reliable and easily accessible data on hazards, vulnerabilities and risks. Disaster loss databases provides for systematic collection of relevant data, and their validation and sharing, for the historical analysis and prediction of disasters.

131.This case study has been adapted from UNDP's 2009 publication entitled, Risk Knowledge Fundamentals: Guidelines and Lessons for Establishing and Institutionalizing Disaster Loss Databases. For more information visit http://regionalcentrebangkok.undp.or.th.
132. UN/ISDR, Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, World Conference on Disaster Reduction, Kobe, Hyogo, Japan, 18-22 January 2005.