2015 GORKHA EARTHQUAKE:

EVALUATION OF NEPAL'S EMERGENCY COMMUNICATION SYSTEMS

VERSION 1.0

Nuwan Waidyanatha
nuwan@lirneasia.net

LIRNEasia
Pro-poor. Pro-market.

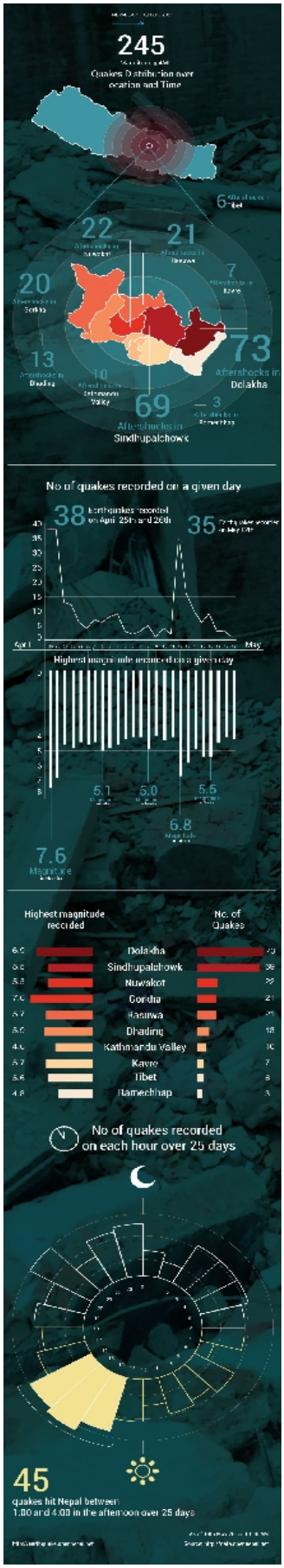
Colombo, Sri Lanka

and

Internet Society
Nepal Chapter

Kathmandu, Nepal

2016



FOREWARD

It was barely a month after LIRNEasia conducted a course on broadband policy and regulation in Nagarkot, that Nepal was affected by the Gorkha Earthquake. Our hearts went out for the people of Nepal who suffered from a series of tremblors, power and communication outages and many difficulties. We managed to convey some support for the immediate relief activities undertaken by our partner, the Internet Society of Nepal. But we concluded that what would be most valuable would be a contribution in the form of knowledge.

Nuwan Waidyanatha, Senior Research Fellow at LIRNEasia, kindly consented to undertake this challenging assignment. He was among the first to provide relief to those affected by the 2004 Indian Ocean Tsunami on the East Coast of Sri Lanka. Subsequently, he managed LIRNEasia's large HazInfo project focused on early warning supported by the International Development Research Centre of Canada in 2005-07. Stemming from that project, he generated many publications in the Disaster Risk Reduction field. He was one of the pioneers in deploying the Common Alerting Protocol. Through his deep involvement in the work of the Sahana Foundation he has also achieved recognition as an expert in the relief and response phase of disasters. He is much in demand as a trainer.

We at LIRNEasia have always responded to disasters in two ways. The first is as human beings who try to reach out and help those whose lives have been shattered. The second is in using the disaster as an opportunity to learn how to reduce risks in the future and to provide relief and response more effectively. We believe that the comprehensive study conducted by Nuwan Waidyanatha is exemplary of the latter. He has successful melded his extensive knowledge of the subject with observations on the ground to present actionable recommendations that are of value not only to Nepal but also to similarly situated countries. We hope that it will contribute to actions that will result in the saving of lives and reducing harm to livelihoods.

On behalf of LIRNEasia I thank all those who assisted Nuwan in his assignment and our staff and well-wishers who contributed to the fund that made this work possible.

ACKNOWLEDGEMENT

LIRNEasia and the Internet Society Nepal (ISOC-Nepal) Chapter expresses their gratitude to private donors who provided the funds for this activity. Without their financial support this report would not have been possible. The report recognizes Mr. Bipin Aryal, of the investigation team, for his efforts in the research activities. ISOC-Nepal was instrumental in facilitating the field mission and arranging all the face-to-face meetings with the relevant stakeholders. Special appreciation to all the organizations and individuals in Nepal who shared their experience from the earthquake and knowledge on the state of emergency communication in Nepal; especially the Chautara Community, Ministry of Information and Communication Technology, National Telecommunications Authority, National Emergency Operation Center, National Information Technology Center, Nepal Police, Nepal Armed Police, World Food Program, Kathmandu Living Labs, Digital Humanitarian Network, Association of Community Broadcasters, Nepal Telecom, SmartTel, Nepal Wireless, WorldLink, Mercantile, Subisu, Web Surfer, Internet Service Provider's Association of Nepal, and the Computer Association of Nepal. A special appreciation of the the Global Internet Society (ISOC) for their generous financial assistance to support the printing of the report.

LIST OF TERMS AND ACRONYMS

BC-DRP	Business Continuity Disaster Recovery Plan
BTS	Base Transmission Station
CAD	Computer Aided Dispatch
CAN	Computer Association of Nepal
CAP	Common Alerting Protocol
CASA	Cross-Agency Situational Awareness
CDMA	Code Division Multiple Access
COW	Cell On Wheels
DDRC	District Disaster Rescue Committee – Administrative Level 4 (VDC)
DEOC	District Emergency Operation Center
EDXL	Emergency Data Exchange Language
EOC	Emergency Operation Center
ETC	Emergency Telecommunications Cluster
FM	Frequency Modulation
GECO	Government Emergency Communications
GIDC	Government Information Data Center
GLOF	Glacier Lake Outburst Flood
GoNP	Government of Nepal
GPS	Global Positioning System
GSM	Global System for Mobile
GSMA	GSM Association
HF	High Frequency
HLR	Home Location Register
IBM	International Business Machines
ICT	Information Communication Technology
IFRC	International Federation of Red Cross and Red Crescent Societies
IMS	Information Management System
IP	Internet Protocol

ISOC	Internet Society of Nepal
ISP	Internet Service Provider
ISPAN	Internet Service Provider's Association of Nepal
IT	Information Technology
ITU	International Telecommunication Union
ITU-D	International Telecommunication Union Development
JICA	Japan International Cooperation Agency
KLL	Kathmandu Living Labs
KM	Kilometer
KPI	Key Performance Indicator
MNO	Mobile Network Operator
MOHA	Ministry of Home Affairs
MOICT	Ministry of Information and Communications Technology
MSC	Mobile Switching Center
MW	Mega Watt
NEOC	National Emergency Operation Center
NETCOM	Nepal Emergency Telecommunications Continuity Management
NETP	National Emergency Telecommunications Plan
NGO	Non-governmental Organization
NITC	National Information Technology Center
NPR	Nepal Rupee
NT	Nepal Telecom
NTA	Nepal Telecommunications Authority
OCHA	Organization for the Coordination of Humanitarian Affairs of the UN
OSM	OpenStreetMap
PDNA	Post Disaster Needs Assessment
PSTN	Public Switched Telephone Network
RASTA	Risk Assessment of Telecommunications Availability
REA	Rapid Environment Assessment
RM	Resource Messaging

RREACT	Rapid Restoration of Access to Telecommunications
RTDF	Rural Telecommunications Development Fund
SAFIRE	Sahana First Response
SAMBRO	Sahana Alerting and Messaging Broker
SAR	Search and Rescue
SASEC	South Asia Sub-regional Economic Cooperation
SITREP	Situational-Reporting
SMS	Short Message Service
SOP	Standard Operating procedure
SSF	Sahana Software Foundation
TSP	Telecommunications Service Provider
TV	Television
UHF	Ultra High Frequency
UN	United Nations
UNDP	United Nations Development Program
US	United States
USF	Universal Service Fund
VDC	Village Development Committee
VHF	Very High Frequency
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
VSAT	Very Small Aperture Terminal
WFP	World Food Program
WWW	World Wide Web

TABLE OF CONTENTS

LIST OF BOXES

LIST OF TABLES

LIST OF FIGURES

1 EXECUTIVE SUMMARY

Box 1: A Kathmandu Experience

"Ten minutes after the earthquake I could only use my mobile data and I posted on Facebook. Then the data quality and connectivity depreciated fast. I couldn't call the US Embassy Warden. He was trekking in the Solukumbu District. I texted him and he texted me back. There was no mobile voice for several days, it was all data but on and off. After two days electricity came on in our house." - Interview with Neil Horning, Digital Humanitarian Network

The Nepal Telecommunications Authority (NTA) estimated 40% of the damaged telecommunications to have been restored by the 2nd day. On the first day, accounting for their personal losses was the primary objectives of the Telecommunication Service Providers (TSPs). Thereafter, they deployed their recovery teams on April 26th. After power and roads were restored, the TSPs had 70% of the services up by the 5th day, and 100% by the 7th day.

VHF (short range) and HF (long range) communications, with cross-band technology, were the only reliable mode for 7 days. The International community stepped in to provide satellite phones and VSAT stations to support the humanitarian organization. All the Telcos freely gave away or loaned voice and data for several weeks.

Nepal is home to over 500 community radio stations. 75 of them could not broadcast for 3 days (only 7 were decommissioned). Nepal television and radio stations were instrumental in broadcasting Search and Rescue (SAR) and relief information to the public. Most importantly the broadcast media were the reliable source in mitigating rumors to avoid panic.

Nepal Telecom (NT) – Nepal Doorsanchar Company Limited – has the largest network in the country. They suffered the most damage to their transmission systems, Base Transmission Station (BTS) and buildings. Smart Telecom Private Limited (SmartTel), servicing rural Nepal, lost one BTS and the rest were intact. They utilizes other Internet Service Provider (ISP) transmission systems, not their own, to transport their Internet Protocol (IP) packets between BTS and Data Centers. Those ISPs lost their transmissions at various nodes and lines.

Once the batteries that could power the BTS for 24 hours had drained their capacity, it was after the three days that the ISPs were able to power their transmitters, relays and small BTS.

They first used generators and then switched to solar energy by the second and third week after the earthquake. Now Nepal, especially the ISPs, is switching to solar energy to power the last-mile communications.

Telecom Engineers, in Nepal, and the Telecom emergency operation centers worked around the clock to restore services. With daily tremblors, Telecom engineers were wary of working at heights on top of antennas. Some working in rural areas could not communicate their distress to the head office. Other engineering teams had lost their equipment. Engineering rescue teams were dispatched where some had to travel by foot to support the immobilized teams.

Rooftop based antennas were destroyed when the buildings supporting them collapsed. Heavy batteries that were not bolted to the ground damaged the building walls and caved through the roofs. Those independent BTS with ground mounted antennas were unharmed. However, in some cases sparks ignited the flammable Vinyl walls of the BTS shelters. Make-shift shelter material were used to protect those BTS hardware from the rains until permanent shelters could be built.

Powering the terminal devices and access points for citizens and emergency responders to use the Internet for communication was the main hindrance. The Internet Society of Nepal (ISOC-Nepal) and the Internet Service Provider Association of Nepal (ISPAN) distributed electricity generators and solar panels to ISPs. They also setup mobile phone charging stations for citizens and emergency services.

Coordination of SAR and relief efforts was an immense challenge for the Government of Nepal (GoNP). GoNP has neither established a Cross-Agency Situational-Awareness (CASA) platform nor an integrated Incident Command and Control System (ICCS). All the emergency services were working independently improvising and adjusting to the situation presented to them. There are reports of some local Government and emergency services fled from their duty posts because they could not cope with the chaos and meet the demands of the victims.

Everyone was relying on the Internet. New media and crowd-sourcing took precedence in Nepal and had been critical to the sharing of information among victims and the relief and rescue organizations. The Twitter account hosted by Nepal Police, immediately after the earthquake, has now evolved into to one that continues to be an everyday utility. The National Information Technology Center (NITC) developed a spur of the moment web-based solutions for consolidating the response, relief, and rehabilitation information. NT setup a 1234 short

code with a 40 desk call center to support the SAR and relief operations.
Taking in to consideration lessons from the recent earthquake, the literature, and the expectations of the stakeholders, this report recommends a series of actions based on good practices that will help achieve the identified goals. These are intended to complement the National Emergency Telecommunications Plan[1] (NETP) Goals 1 and 2 (NETP 2013, pp 66) and Objectives. Table 1 discusses a set of SMART[2] recommendations. These recommendations are discussed in section 9 in detail.

Table 1: Recommendations, aligned with NETP, and expected outcomes

NETP Objectives	Recommendations	Expected Outcome
(II) Telecommunications Survivability and Availability:	Assess and mitigate the risk to emergency communication systems, adopt BC-DRP best-practices and guidelines, and set infrastructure construction and operational standards	
Upgrade and regularly maintain communications systems and capabilities to ensure effective operation through appropriate resource allocations (NETP 2013, pp 78)	(a) Train a set of Trainers in assessing the survivability and availability of emergency telecommunications (NETP 2013, Action Plan 8.3.3, pp71-72)	(i) Exposure to methodologies and tools for assessing resilience of the systems (ii) Prioritize mitigation actions to improve the robustness of systems (iii) Realize the requirements to support BC-DRP and RREACT programs
Make sure that appropriate and continuous training and exercises are made available to relief agencies and responders so that they all have common approaches, enhanced technical expertise and better response capabilities (NETP 2013, pp 76)	(b) Build capacity in BC-DRP best-practices for developing a set of guidelines for the Nepal context (NETP 2013, Action Plan 8.7.3, pp 78-80)	(i) Exposure to BC-DRP best-practices and assessment tools (ii) Strengthen national and stakeholder (customized) BC-DRPs and guidelines (iii) Assure minimal service downtime times and reduce economic losses (iv) Ensure coordination and collaboration for the restoration of public communications
	(c) Facilitate a platform for stakeholders to contribute evidence and study regional best-practices in realizing and setting infrastructure building and restoration guidelines (NETP 2013, Action Plan 8.2.3, pp 69-70)	(i) Improve the resilience of the infrastructure and reduce economic losses (ii) Give communications assurance to the crisis and emergency response organizations
(II) Rapid Restoration of	Capacity to rapidly restore the GECO and develop ways and means for	

[1] NETC. (2013). National Emergency Telecommunications Plan, Final Report, Nepal Telecommunications Authority, submitted by Enter Information & Communication Technology Nepal.
[2] Specific Measurable Attainable Realistic and Timely (SMART) Goals

Access to Telecoms:	ensuring seamless public access to telecommunications during crises and emergencies	
Formulate policies strategies and guidelines that promote emergency telecommunications on disaster management continuum in line with Tampere Convention ITU Resolution and National Frameworks (NETP 2013, pp 67) Set up and formalize a decision making structure with clearly defined leadership roles for coordinating emergency communications capabilities considering national settings (NETP 2013, pp 69)	(a) Build a Mobile Communication Truck to serve as an interconnection, access point and transmission hub (Not in NETP Action Plans)	(i) Be able to provide communications in places that has no coverage to utilize in emergencies and training (ii) Contribute the lessons learned from developing the unit to emergency communications research and practitioner community
	(b) Build Grab-n-Go kits to rapidly restore access points, transmissions, and power to computing and communication devices (complements NETP 2013, section 5.3.2, pp 56)	(i) Research and develop practical and country context systems (ii) Build national capacity to rapidly restore and continue communications (iii) Contribute to the SAARC agreement signed in 2011 with supporting rapid response in the region
(III) CASA and ICCS platform:	Apply all-hazards all-media emergency communication practices, integrate stakeholders, vertically and horizontally, at the national and local layers, and provide a common operating picture	
Recognize the role and the importance of ICT technology as an integral tool in emergency response (NETP 2013, pp 84) Develop an integrated network and cooperation mechanism for mitigation, response and recovery capability to communicate in all phases of natural disasters (NETP 2013, pp 70) Develop a robust and responsive national emergency alerting, warning and activation system (NETP 2013, pp 72) Provide facilities to communicate among all sectors of the stakeholders (NETP 2013, pp 74)	a) Conduct a multi-stakeholder awareness workshop to realize the needs for CASA and ICCS platforms (NETP 2013, Action Plan 8.4.3, pp 73-74, Action Plan)	(i) Exposure to interoperability standards and procedures (ii) Foster a forum to collaborate and contribute to the development of disaster management ICT systems (iii) Experience the concepts of impact-based warning, all-hazard all-media alerting, and incident management
	(b) Pilot-test a simple all-hazards all-media CASA platform and an integrated ICCS for better coordination of warnings and incident management.	(i) Better understand the EDXL-CAP, EDXL-SITREP and EDXL-RM interoperable standards and procedures (ii) Assess the capacity requirements for operationalizing a national CASA platform and ICCS (iii) Realize the policy and legal implications for institutionalizing a national CASA platform and ICCS

2 THE "CHAUTARA[3]" EARTHQUAKE EXPERIENCE

The Nepal Telecom tower (Figure 1 left) was dangerously leaning, on the verge of collapse. The NCell tower (Figure 1 right) was vertically erect but on the roof of a vulnerable building. NCell resumed services after 2 days and NT after 4 days. Both towers have now been relocated.


Figure 1: NT and NCell Towers

SmartTel tower and base station located outside of the Chautara Bazaar area were unharmed. However, their back-haul was riding on leased ISP lines that were disrupted. ISP BTS had lost power for SmartTel to provide mobile services. WorldLink ISP had their battery stolen. They resumed service after 12 days after restoring power with solar and diesel generators. WorldLink was responsible for serving 20 neighboring communities with 7 distributed access points.


Figure 2: Solar powered chargers

Radio Sindhu FM station in Chautara, was completely demolished. They jerry-rigged a tower with bamboo hoists to resume transmission after 2 days. Without power, television was obsolete. **The town was in total darkness for 3 weeks**. Humanitarian responders set up solar-powered mobile phone charging stations. Some trekked almost a day in search of a Telecom signal to alert their loved ones. The Nepal Police operated HF radios were the only source for communicating their distress and receiving information at the early stages.

Chautara is 328 KM from Kathmandu in Sindhupalchok District. It is a small town with a population of ~2000 inhabitants. An estimated 150-200 lives were lost there. The town hospital was totally demolished. Agriculture and trade are their main livelihoods. Public transportation is scarce.

Figure 3: Chautara at the end of the road network

[3] Chautara . (2015). Wikipedia synopsis of the Chautara situation report of the 2015 Nepal Earthquake: https://en.wikipedia.org/wiki/Chautara#2015_Nepal_Earthquake

3 PURPOSE

On Saturday, 25 April 2015 at 11:56 local time, a 7.6 magnitude earthquake was recorded by Nepal's National Seismological Centre (NSC). It struck Barpak in the historic district of Gorkha, about 76 km northwest of Kathmandu. Nepal had not faced a natural shock of comparable magnitude for over 80 years.

LIRNE*asia,* in close collaboration with the Internet Society (ISOC) of Nepal, carried out a study to understand the reliability of ICTs in supporting emergency communication. LIRNEasia understands the importance and the role of ICTs in disaster risk management and has conducted several studies for the United Nations Economic and Social Commission for the Asia and the Pacific (UNESCAP), in this regard. Those reports, from the UNESCAP studies, emphasize the difficulties organized support services face when access to infrastructure, such as telecommunications, is limited.

This report discusses the findings from a field mission carried out in Nepal during the month of December 2015. The report also provides a set of recommendations that the crisis and emergency communications community in Nepal may take into consideration in strengthening their critical communication infrastructure.

4 BACKGROUND

The NETP Part I – Introduction (NETP 2013, pp 02-45) provides a detailed description of the Nepali emergency communications and disaster management. In the context of this report and to provide an update on the current state of activities, the following sections briefly discuss the current state of Nepal's emergency communications:

1. Governance and Leadership
2. Operational Coordination
3. Plans and Procedures

4.1 Governance and Leadership

The Government of Nepal has an established organizational structure with multiple Government Organizations led by the The Ministry of Home Affairs (MoHA). The MoHA and the Ministry of Information and Communication Technology (MoICT) are working together to

contribute to improving emergency communications in Nepal. A first step has been involving the NTA to develop the NETP. The readers are encouraged to read Part II – National Emergency Telecommunication Plan for Nepal (NETP 2013, pp 66-78).

The NTA developed NETP is being revised to be submitted for Cabinet approval. It adopts some of the Nepal Emergency Telecommunication Continuity Management System (NETCOMS) principles by considering Business Continuity and Disaster Recovery Plan (BC-DRP) related policies and practices. ITU is assisting NTA with developing the NETP/NETCOMS. Standard Operating Procedures (SOPs) at National and Organizational layers are urgently required. The TSPs such as NT, SmartTel, ISPAN (Mercantile, Subusi, Web Surfer, and WorldLink) are keen to improve their BC-DRPs.

4.2 Operational Coordination

MoHA coordinates the SAR and Relief operations in Nepal. The National Emergency Operation Center (NEOC) supports MoHA with the laborious work of collecting, processing, and presenting the ground information. At present NEOC does not provides information systems to support crisis response and management. The need has been identified and NEOC is planning the system requirements.

The Chief District Officer, appointed by the MoHA, leads the District Emergency Operation Center (DEOC). Through the DOEC the MoHA administers SAR and relief operations. Other response organizations such as police, military, and NGOs are debriefed at the DEOC. The DEOCs do not have access to an incident management system to coordinate the information with relevant emergency services and to communicate with the MoHA. It is all manually processed on paper and communicated via phone or FAX.

4.3 Plans and Procedures

The Nepal Broadband Policy[4] and ICT Plans have been approved by GoNP. MoICT and NTA are in the process of developing action plans. The broadband experience has been less than 4 years. Government of Nepal is planning such that it ensures increased investments in the telecommunications sector, the establishment of a resilient public service broadcasting sector,

[4] Nepal Broadband Policy, 2071 (Draft), Ministry of Information and Communication, Government of Nepal. Consulted 2015 February 05 on the world wide www: http://www.nta.gov.np/ne/component/joomdoc/Broadband%20Policy-Draft.pdf/download

and the convergence of the ICT sector that will enable Nepal to make the best use of the opportunities provided by technological developments.

The Nepal Five Year Plan has a five-person committee, including members of MoHA, MoICT, NTA, and National Planning Commission (NPC), is setting the action plans for utilizing the Rural Telecommunications Development Fund (RTDF), namely the Universal Service Fund (USF). This will allow Nepal to extend the fiber networks and connectivity in rural areas. Emergency Services will also benefit from this expansion. The Nepali TSPs would also benefit from carrying their back-haul voice and data streams.

The initial intention of the RTDF project is that of sharing the network with health, education, and e-Government services. The funds are expected to be shared with partners in selected districts. At present consultants from Manipal University are designing the projects. Thereafter, they will undergo an approval and procurement process. One objective of the design is to develop broadband services in the fourteen most earthquake effected districts.

In the medium and long term recovery efforts, members of the Nepal Emergency Telecommunications Cluster (ETC), led by the MoHA and the MoICT are setting the basis for a Nepal Emergency Telecommunications Continuity Management System[5] (NETCOMS). It is uncertain whether a charter has been formally mandated. However, the GoNP has established a “telecommunications cluster”, which could potentially serve as Nepal's Emergency Communications Charter. A critical question the GoNP is trying to find means to answer is “how can Nepal build resilient ICT systems to support crises and emergencies?”

5 STUDY APPROACH

In relation to the Nepal Earthquake, the Research Team undertook the following actions:

1. Studied the current situation and existing circumstances of ICT use in Emergency Telecommunications and Disaster Management; specifically, focusing on alerting/ warning, SAR, and relief operations.
2. Evaluated the emergency telecommunications survivability (including contingency plans and considering country-specific risks to telecommunications and supporting infrastructure) and availability of services to support emergency management work

[5] NETCOMS (2015). NETCOMS is defined in the Nepal Emergency Telecommunications Framework. It is a working collaboration between NTA and ITU (Authors and Publishers unknown). Consulted 2015 December 23.

flows

3. Identified capacity requirements for the rapid restoration of access to telecommunications towards developing or enhancing an existing program to support seamless emergency communications
4. Assessed ICT resources and processes available, from the perspective of disaster information management systems, to effectively meet the continuing challenges of resilience
5. Understood the challenges of adopting a multi-stakeholder approach to managing emergencies by sharing situational information over an interoperable common platform for improving emergency coordination
6. Included all the above mentioned findings and any other information deemed necessary in a Technical Report

The study applied an iterative methodology whereby interactions were designed to seek feedback from the Nepalese disaster management community. In terms of the user research, a design thinking approach was applied. It is generally broken down into 5 phases: Empathize, Define, Ideate, Prototype, and Test. This methodology harmonizes with the process described in NETCOMS. However, this report only goes to the extent of completing the Empathize phase to capture lessons from the 2015 Nepal Earthquake and the Ideate phase with the analysis and providing recommendations.

A field mission was carried out, November 24 – December 01, 2015, to interact with ICT Experts, Disaster Management Experts, and Community Members. These interactions involved in-depth analysis of the state of the Nepalese emergency communications with respect to the April/May 2015 earthquake.

6 SYNTHESIS - DISRUPTION TO TELECOMMUNICATIONS

NTA reported 525 BTS, 10 Transmission Towers, 2 Fiber Back-hauls, 15 Microwave links, and 197 Physical Buildings to be affected (NTA 2016[6]). GSMA (GSMA 2016B) reported 16.75% of 2G and 23.32% of 3G mobile sites to be down. NTA reported 38% of 2G and 4% of the 3G

[6] NTA – Nepal Telecommunications Authority. (2016). Nepal's Experience in Responding to a Disaster: A Telecommunication/ICT Sector Prospective, Ananda Raj Khanal, (Director, NTA), INET Kathmandu 2016, Nepal. Consulted on 17 & 18 April, 2016.

network sites to be down. GSMA seems to be reporting an average over a time period. NTA is reporting the maximum reported sites down, the count taken on April 25th. After the batteries and diesel generators drained, after 48 hours, a significantly large number of GSMA/WCDMA sites went down.

Relatively, the communications sector suffered the least amount damages and losses (PDNA, Executive Summary, pp XV). The total damages and losses in economic flows were estimated at NPR 3.6 billion (~US$ 32.4 million) and NPR 5.1 billion (~US$ 46.0 million), respectively. The electricity sector suffered damages of NPR 17.1 billion (~ US$ 154.1 million) and losses of NPR 3.4 billion (~ US$ 3.4 million). Recovery and reconstruction costs were estimated at NPR 4.9 billion (US$ 30.6 million). NPC is revising the PDNA because the initial reporting methodologies may have been unclear and the estimations were preliminary.

6.1 Nepal Telecom

Nepal Telecom (NT) is the largest TSP in Nepal. They offer voice and data over GSM, CDMA, and PSTN services. The company's telecommunications had lost electricity for 3-5 days during the disaster. NT offered free voice and data for two months to their customers, after the earthquake.

On day 1 of the earthquake, NT had 109 incidents reported on damages and service disruptions. Contacting their own staff was a challenge. Some engineers had to trek to find signals off other BTS to report the local situation. Twenty five teams were deployed to restore the transmission, buildings, and antennas. It took NT 15 days to recover to full capacity. A Huawei and NT combined management team led the restoration work. Besides assisting with restoration of BTS, supplying generators was the great contribution by Huawei.

NT owns and operates their infrastructure (nothing is outsourced), unlike other operators. A few fiber cables were cut. The main challenge was powering the transmission equipment; namely the BTS and Relays. The (Mobile Switching Center) MSC and (Home Location Register) HLR were unaffected. One satellite link was transported by helicopter. The prepaid service billing server hard disk was damaged. As a result the prepaid customers had lost their calling and data services. NT implemented a quick fix to have the service reinstated in less than a day.

Very few antennae were damaged. A BTS that was partially damaged by the April 25th

earthquake, but was still functional, was completely brought down by the May 12th tremblor. Twenty one unsafe sites were completely dismantled. A typical rooftop installation, on a three story building, would have the CDMA antennas 15 meters tall and GSM antennas 7-8 meters tall. NT is experimenting with tripodal antenna towers that are shorter and lighter to fit on rooftops. These are being reduced to lighter 3 inch GT pole tripod style antennas that are 6 meters tall. They are planning to remount all batteries and powering rooftop antennas from the ground floor of the buildings. Even with the new policies, building owners and their neighbors are scared of rooftop based antennas.

Nepal Engineering Association Students assessed the safety of the buildings. Building walls and roofs were damaged by insecurely fastened heavy tumbling batteries. Some of the batteries sparked setting the Vinyl wall material on fire. The Vinyl prefabricated equipment sheds were part of the Japanese project. New company policies are transferring all batteries on all rooftop based BTS to the ground floor and securely fastening them. A key reason to install the batteries and other hardware in houses is to prevent from theft and vandalism.

6.2 SmartTel

SmartTel is a GSM TSP operating under a unified license. They were initially licensed to bridge the rural gap in 25 Districts. They were operational in the affected 14 districts. On the first day 40% of their services were functional. By the 5th day 60% was up and it took 9 days before more than 90% of the services could be restored.

The SmartTel infrastructure development is outsourced to other companies. Those companies were reluctant to restore fallen towers because of the frequent tremblors. Their back-haul transmissions are on outsourced ISP infrastructure. ISPs had difficulty managing the battery power beyond the first 24 hours. Getting new equipment and personnel across to restore services was a challenge.

6.3 Internet Service Providers

ISPAN estimated a common loss of USD 200,000 for all the ISPs. Broken fiber, access to power, and human resources were the main challenges to the continuity of Internet services. Solar panels were utilized in many areas where main grid power was unavailable. It took one month to switch to main-grid electricity. Nepal Electric Company has laid a fiber network using

their electric poles. The ISPs lease these lines for their transmission. Many poles had fallen to the ground breaking the transmission links.

Nepal Wireless, Mercantile, Subisu, WorldLink, Web Surfer, and NT are the main ISPs operating in Nepal. Installation principles re that cities and valleys use fiber. Mountains use microwave point to point links with one dish on the slope of a mountain directly pointing to another to the face of a mountain across without any obstacles in between. Point-to-point wireless works better in mountains and not in flat valleys with obstacles. Fiber is the preferred choice in the valleys. Fixed line ISPs are less than three percent of the market share.

WiMax on 5.08 GHz is most popular. Facebook, Viber, What's App, Wechat are common applications. Ninety eight percent of the ISP market is driven by commercial ISPs. Some banks and VPNs use Ku-band VSATs for their IP network. These corporate customers were given priority over the households in the restoration efforts. For example, 90% of Subisu clients are corporate and not households. They had to run their own EOC handling each client at a time, diagnosing the issues and then fixing them.

Nepal Wireless lost 2 towers. Nepal Wireless conducting Telemedicine, School (education), village digital literary programs that are also building capacity and communications services in the villages. The total cost of ownership is calculated on the number of relays between a village and gateway (power ~ 40 KW/link). They already have experience operationating in 90 villages. Another 50 connections are in progress. The next generation efforts are looking to pilot TV Whitespace on the UHF channels.

7 SYNTHESIS - ICT COMMUNITY RESPONSE

The National and International telecommunications community responded to the earthquake with the goodwill to restore emergency communications. The Internet became an important tool for crisis response and management. There were several projects that were hosted to crowd-source disaster information and exchange information using new media. Although some of the solutions were less known to the general public they were useful to the humanitarian response organizations for collating information. Others were trying to cease the opportunity looking to pilot their solutions. Three separate companies wanted to test TV Whitespace technology for Internet. Drones were flown to collect data, mostly for experimentation. Not much value was added to the response and recovery work.
The subsections discuss those initiative that made an impact.

7.1 Police Social Media

Nepal Police introduced twitter account (@nepalpolicepq) had been helpful to keep citizens informed. In some cases citizens were able to report crimes using the same twitter account. In one instance numerous reporting of a bus charging people 4 times above the normal price brought the criminals to justice and NPR 800,000 was returned to the bus riders. Others reported that women and infants were not receiving necessary care and Nepal Police was able to respond with the necessary supplies.

Facebook was instrumental to identifying those who were safe (locating missing people) and for authorities to provide situation reports. In a few instances Facebook served as a medium for reporting incidents. One instance, in Dolakha, citizens used Facebook to report a landslide and request for SAR. Nepal Police exercised an framework that involved interactions between police crisis communication practices, institutional elements, and convergence behaviour[7].

7.2 QuakeMap

QuakeMap was used as one of the key information sources in Nepal's earthquake response and relief work. In addition, they created Situation Reports periodically based on the information available in quakemap.org and other sources. Quakemap.org was an initiative led by Kathmandu Living Labs (KLL) with on-site coordination support from NepalMonitor.org and remote support from Humanity Road. The instance went live 1 days after the earthquake on April 26th. They received over 2000 reports.

QuakeMap was essentially an Ushahidi instance to share incident reports with all the response organizations. They set up a SMS hot-line to receive reports as well as to notify various groups of each other's response efforts. Approximately ten percent of the records were received through SMS but most of it was through the data communication channels, including social media and an online form.

The utility of the QuakeMap[8] was mapping out actionable reports, and mapping what responding groups were doing. The Nepal Army exported hundreds of reports, conducted a second round of verification, and prioritized relief efforts accordingly. Public trust was a key

[7] NP – Nepal Police. (2016). Role of Social Media in Disaster Response, DIGP Rajib Subba, PhD, (Director Communications Directorate, Nepal Police) INET Kathmandu 2016, Nepal, 17 & 18 April 2016.

[8] Ushahid case-study of the QuakeMap. Consulted 2016 March 08 on the www: https://www.ushahidi.com/case-studies/quakemap

factor in receiving reports, which was established by high profile media coverage early in the process, once a critical mass of reports had been reached. An objective of QuakeMap was to bridge the information gaps between the relief organizations and the victims.

Once the public began reporting to the platform, organizers felt an obligation to take all possible actions to make sure reports reached responding organizations. Most responses that could be confirmed came from volunteer organizations. Himalayan Disaster Relief Volunteer Group, launched from "Yellow House" used QuakeMap extensively, and became one of the top overall distributors of aid during the relief effort. Crowd sourcing is an efficient way to receive incident reports. However, validation requires an enormous amount of volunteer time and effort.

7.3 OpenStreetMap

KLL was instrumental to developing several useful OpenStreetMaps (OSMs) to assist the humanitarian response. Some OSM work was carried out a couple of years prior to the earthquake. However, there were no maps for the 14 affected districts at the time of the earthquake. KLL has a large network of volunteers and on the ground personnel. The 9000+ personnel were mobilized to begin assembling earthquake relevant maps. The volunteers did a remarkable job with generating map products for various humanitarian agencies, who otherwise didn't have any source to guide them.

The United Nation (UN) Organizations, the Military, and Government were some of the avid users of the KLL generated maps. KLL had developed several map products in PDF, JPEG, and other relevant document formats. These maps were printed on paper, especially by the World Food Program (WFP) and Canadian DART[9] in the thousands and handed to humanitarian rescue and relief workers. For example, Doctors without Borders, when they arrived in Kathmandu, faced difficulties in deciding where to go and how to get there. OSMs were helpful in determining those logistical issues.

7.4 Humanity Road

Humanity Road's overall disaster response activities for Nepal spanned 49 days. The organization activated its disaster desk on April 25th and stood down on June 12th. Humanity

[9] Canadian Disaster Assistance Response Team is a military organization ready to deploy on short notice. Consulted 2015 December 03 on the www: http://www.forces.gc.ca/en/operations-abroad-recurring/dart.page

Road helped to collect, verify, and process reports coming to the QuakeMap repository. Compilations of the situation reports were used by different humanitarian agencies. Humanity Road was activated for mission specific support by five separate stakeholders[10].

For KLL, the Humanity Road activation provided support for QuakeMap. This included advice on categorization elements, public messaging for the map, overnight support for administration tasks associated with processing incidents into the map, updating and populating location information of pending incidents, and providing a daily 5:00am status report for KLL volunteers starting their day. For this activation, HR received language translation support from Translators Without Borders, and spontaneous diaspora volunteers.

Humanity Road is a member of the Digital Humanitarian Network. Their specialty is "monitoring social media for saving lives". Working with aid providers, Humanity Road offers situation reports, media monitoring and crisis mapping support for catastrophic disaster. An important aspect for crisis and emergency

7.5 Micromappers

Micromappers provides a platform for Digital Humanitarians, termed as Digital Jedis, to support disaster responders with a simple click. No prior experience or special skills are required[11]. The Digital Humanitarian Network (DHN) used the Micromappers platform to analyze social media and photograph sites and then tag those posts. These digital resources were pasted into QuakeMap.

7.6 Mass Displacement of People

Outputs from the WorldPop project mapping team rapidly produced updates of static population density maps with a resolution of 100x100 m, including gender and age distribution for Nepal. This data were used by the UN Organization for the Coordination of Humanitarian Affairs (OCHA) and other key relief agencies to estimate the number of people affected and the needs which had to be met. The Flowminder/WorldPop mobile analysis team then used this data in combination with the NCell anonymized data on 12 million mobile phones in

[10] HR – Humanity Road. (2015). Nepal Earthquake After Action Review, HUMANITY ROAD. Consulted 2016 Apr 04 on the www: http://humanityroad.org/nepal-eq-aar/

[11] Micromappers Nepal Earthquake data. Consulted 2015 October 11 on the www: http://clickers.micromappers.org/project/150425104337_nepal_earthquake_information_provided/

Nepal, to document and release data on the impact of the earthquake on population movements.

After adjusting for normal movement patterns, which would have taken place in the absence of the earthquake, an estimated additional 500,000 people had left the Kathmandu Valley two weeks after the earthquake. The majority of these went to the surrounding districts and the Terai areas in the South and Southeast of Nepal, something which was previously unknown. Two weeks after the earthquake an estimated 1.8 million people above normal levels had left their home district[12]. Among people with homes in the Kathmandu Valley, an estimated 500,000 people more than expected had left the Valley.

7.7 Disaster Management Software

Members from the Indian IT community approached Sahana Software Foundation (SSF) requesting to assist them with configuring the Sahana software for supporting the Nepal earthquake relief operations. United Nations Development Program (UNDP) and IBM had also hosted instances of the Sahana Software[13]. The United Nations launched the Multi-cluster Rapid Assessment[14] (MIRA) to assess the needs of people. The utilization of the versatile Sahana and MIRA was none or low. Such systems are effective when operationalized in advance of a crisis and capacity is developed beforehand. The National Information Data Center developed a quick solution to store and report the GoNP supported relief data.

7.8 Story Cycle

Story Cycle[15], similar to MySpace, is a social media platform for humanitarian communities of practice to collaborate. The intent of the developers was to offer a the communities to build their own cyber presence, predominantly with a functionality built in to support the recovery phase and rebuilding. They would add multimedia stories of their village damage and losses. Those stories are compiled as a village profile. The profile is leveraged to request for

[12] Flowminder analysis of the Movement of Populations. Consulted on the 2015-10-10 on the www: http://www.flowminder.org/case-studies/nepal-earthquake-2015

[13] SITREP of Sahana software launched in support of the Nepal earthquake. Consulter 2015 October 10 on www: http://sahanafoundation.org/nepal-earthquake-2015-sitrep-3/

[14] MIRA platform designed to record accurate and timely information of people affected by emergencies. Consulted 2016 Feb 10 on the www: http://un.org.np/resources/mira

[15] Story Cycle. Consulted 2015 November 30 on the www: http://www.storycycle.com

assistance to rebuild their community. The community would create their own projects. The donors would distribute funds to those projects. The community would visually share their project progress, using online tools, with the donors. Story Cycle, a private entity, would charge the project a nominal commission (percentage of the project funds ~ 3-5%) to generate their revenue and sustain.

7.9 Emergency Communications Cluster

During the earthquake the International ETC, MoICT, MOHA, Ministry of Defense (MoD), and the WFP established the Nepal ETC[16]. Many other Organizations, immediately, joined the group. This working group was most useful in coordinating the restoration of telecommunications and providing a satisfactory service in support of the humanitarian response.

The International ETC setup VSATs and communications hubs (or Kiosks) to support the humanitarian operations. Their services include providing Internet, ICT help desks, radio programming, and training. While some services were accessible to the public, ETC objectives were to provide communications to the humanitarian response organizations.

International ETC decommissioned its operations in October of 2015. However, some of the founding members of Nepal ETC are now part of a working group that is assisting NTA to revise the NETP.

7.10 International Telecommunication Union

GoNP is a signatory to the Tampare Convention[17]. However, Nepal has not ratified the treaty. Nevertheless, ITU provided communications units had been dispatched to various affected areas to support SAR operations. They included 35 Iridium satellite phones, 10 BGAN terminals along with 10 laptops for the BGANs, 25 solar chargers for satellite phones and solar powered batteries.

[16] Nepal ETC resource page with documents and information. Consulted 2015-October-25 on the world wide www: https://www.etcluster.org/emergencies/nepal-earthquake

[17] Country which are party to the Tampere Convention: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXV-4&chapter=25&lang=en&clang=_en

The equipment was distributed to the MoICT through NTA. Training on the use of the equipment was also provided to different agencies. ITU financed the deployment of the equipment, three months satellite airtime usage and the returning the equipment back to Geneva. ITU provided technical assistance in formulating the NETCOMS-draft.

7.11 Radio Broadcasters

FM Radio broadcaster comprise Nepal Radio (the National Radio) and the 500+ Community Radio Stations covering the country. These radio stations serve as the only mean of education for some remote communities. Most of them are Radio+ stations that have incorporated ICT such as the use of Facebook pages and the use of Twitter and other social media.

Radio stations were important in disseminating SAR and relief/rehabilitation specific information to the earthquake affected communities. Radio stations were helpful in squelching rumors. The Stations were also sharing 4W matrix information as to who was doing what where and when. At the same time informing listeners of what not to do and what to do to getting through the crisis.

In some instances information was received from MOICT and MOHA by email. In most case the Radio Stations, themselves, took on the initiative to research the information and then broadcast to the public. District Administration Offices were a key information source.

Community Radio, including Radio Sindu, which the research team visited, did not have any BC-DRP with necessary SOP to react to emergencies. The engineering elements have some contingency planning in place. However, none of it is formal, planned, and rehearsed. There is a need for a National Community Radio Policy. Also a need for the allocation of a Community Radio Emergency Band (frequency) that all stations can harmonize on.

A few radio stations remain dysfunctional in some areas. The Japanese International Corporation Agency (JICA) is funding the restoration of these stations as well as the roll-out of new radio stations. The ongoing blockade, imposed by the Indian Government, is further delaying the critical radio infrastructure restoration.

8 SYNTHESIS – BEYOND THE EARTHQUAKE

The synthesis discusses the state of the general crisis and emergency management practice based on literature reviews, stakeholder interviews and surveys of recent activities and prevailing issues. The report does not discuss the current state of ICTs, in general, and the prevailing issues. Such information can be gathered from the Nepal broadband and the ICT policy documents.

8.1 Literature Survey

PDNA report does not extensively discuss the cause and effects. Instead it summarizes the damage and losses, from an economic stand point. PDNA discusses the various sectoral thematic areas, including communications as of the sectors one. The first draft of the PDNA report was an early assessment of the damages and losses. The report continues to be revised with new data. Nevertheless, the damages and losses reported for the communications sector were relatively low compared with others. That comparison does not indicate the estimations of the Telecom subscribers in terms of actual economic losses.

The 2013 NETP Final Report (NETP 2013) refers to the 2007 Framework. The report scope recognizes the need to consider ICTs as a whole when considering the NETP. However, there are newer publications made available by the ITU-D Emergency Communications initiatives that the NETP might consider. The report goes on to extensively discuss all available technologies, including those that are operational and other new technologies that might be considered. GSMA has outlined a set of regulatory best-practices essential for the continuity of emergency mobile telecommunications[18]. These positions were developed in partnership with a number of Mobile Network Operators (MNOs) and suggest ways in which an enabling regulatory environment can be created to ease and facilitate rapid restoration of services by MNOs impacted by emergencies.

As a first step towards understanding the risk, NTA is developing a GIS database of the communications infrastructure. Ministry of Environment conducted Rapid Environmental Assessment Report[19] discusses the cause and effects that the NETP might consider in

[18] GSMA. (2015A). Emergency Telecommunications: Regulatory Best Practices. Consulted 2016 March 11: http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/11/GSMA-Industry-Position_Emergency-Telecoms-Regulation.pdf

[19] The REA Report developed for the Hariyo Ban Program, Wold Wildlife Fund Nepal. Consulted 2016-February-01 on the world wide www: http://www.resourceshimalaya.org/rhf/downloads/recent

shaping the policies for resilience in emergency communications. The REA team evaluated seven field study sites including six districts and Kathmandu valley: Dolakha, Gorkha, Kavre, Nuwakot, Rasuwa, Sindhupalchowk, and Kathmandu valley. The report emphasizes landslide to be an inherent characteristic of the young Himalayan mountain range. Such risks should be considered in telecommunications availability and survivability analyses.

GSMA, under the theme: “when you restore the network you rebuild the human network”, conducted an Earthquake Resilience Program[20]. The program took place two weeks prior to the earthquake. The need for planning and simulations, discussed in the NETP (NETP 2013, Action Plan 6.5, pp 77), is echoed in the GSMA Post Earthquake report[21]. The GSMA report stresses that contributions from and the impact on MNOs should be given priority.

On a scale of 0 to 1, Nepal's commitment to Cyber Security ranks at 0.118, lowest among the SAARC Nations. Emergency and Disaster management information comprises sensitive personal data and mission critical applications. Dissemination of false information, publishing with purpose of forgery, tampering with Computer source documents, unauthorized access to computer materials, damaging any computer or information systems, and leaking of sensitive private information are some of the elements that emergency communications designers and implementers should seriously consider.

There are plans to implement the National Cyber Security Strategy. The strategy, presented by the MoICT, was already approved by the ITU. While GoNP develops plans for Emergency and Disaster Management Information Systems, they must consider IT privacy frameworks and security techniques.

%20papers/2.%20Report-P_1-7.pdf

[20] GSMA. (2016). Mobile Industry Earthquake Preparedness; A focus on best practice and partnership development in Nepal, Disaster Response, GSMA by Rosie Afia. Consulted 2015 October 12 on the www: http://www.gsma.com/mobilefordevelopment/mobile-industry-earthquake-preparedness-a-focus-on-best-practise-and-partnership-development-in-nepal

[21] GSMA. (2015B). Disaster Response – Nepal Earthquake Response and Recovery Overview, GSMA – Mobile for Development. Consulted 2015 December 23 on the www: http://www.gsma.com/mobilefordevelopment/disaster-response-nepal-earthquake-response-and-recovery-overview

8.2 Load Shedding

There is an urgent need to improve the supply of electricity[22]. Nepal relies on domestically generated hydro power and power imported from India. Depending on India for electricity adds to the uncertainties to the communications sector. Nepal has the capacity to produce sufficient hydro-electric and solar power for their total national consumption. There are very little or no investments to improve the sector. It is affected by the current political turmoil which International investors perceive as a risk.

The unreliable electricity and scheduled load shedding[23] forces TSPs to use diesel generators to power their base stations. Carbon emissions impact the environment. During winter months, load shedding can reach 14 hours a day[24]. The GoNP has a strategy to develop solar farms in the flat lands (with attractive conditions) and to harvest solar energy from urban rooftops. These strategies should improve the energy resilience that may improve the business continuity of the TSPs.

Electricity was the main disruptor to the availability of telecommunications. Typically, TSPs account for a 24 hour power outage. Until roads could be restored and electricity generators could be supplied the Telecom access points and transmission equipment could not function.

“About 115 MW hydro power generation facilities under operation out of the 787 MW total installed capacity in the country (on-grid and off-grid) were severely damaged, while 60 MW were partially damaged” - Post Disaster Needs Assessment (PDNA1, ch 11, pp 34). Without electric power communication systems in Nepal could not function.

8.3 Infrastructure Vulnerabilities

It is estimated that approximately ninety percent of the telecommunication towers are fixed on building rooftops. There is no adequate ground to hoist towers in the dense urban areas. Buildings are tightly knit and dense with narrow alley ways and roads. When the buildings that were the base to these antennas collapsed the antenna towers came down with them. Buildings that were leaning against another building with the antenna intact would continue to

[22] Nepal energy situation discusses the dependency on India and the potential areas of improving home-grown energy. Consulted 2014 February 10 on the www: https://energypedia.info/wiki/Nepal_Energy_Situation

[23] Nepal scheduled load shedding, latest schedule. Consulted 2015 February 10 on the www: http://imagechannels.com/page/company_related/Load-shedding

[24] The NCell – Nepal - Feasibility Study, a collaboration with the Global System Mobile Association (GSMA) on Green Power for Mobile initiative.

serve during the critical hours and days. However, when those buildings were declared unsafe the TSPs had to remove the antenna and relocate it elsewhere, resulting in more than a week of interruption to the services.

Nepal relies on India and among many resources one is the International interconnection. The gateway connects to India through fiber and utilizes satellite links for redundancy. The South Asian Sub-regional Economic Cooperation (SASEC) network was approved in 2007[25]. The project involves interconnecting Bangladesh, Bhutan, India, and Nepal. There hasn't been any progress and It is uncertain whether it will be build in the near future, either. There are alternative plans to connect to China as well. However, Indian political domination is forcing delays on these initiatives.

8.4 Government Emergency Communication Network

The GoNP has realized the need to support a GECO. It would serve as the backbone supporting seamless redundant voice and data communications. The primary intent would be to support early warning and first response. The proposed network will comprise facilities of Nepal Telecom (NT) and Nepal Electricity Authority. However, the GECO might consider all available networks to determine an optimal strategy for contingencies.

It is uncertain as to the extent of the communications cellular cover of the terrain, Typically, Telcos measure their coverage by how much they cover the population densities. From a GECO perspective it is important to cover every inch of the ground. Given the inconsistencies of cellular coverage by a single TSP, Nepalese maintain SIM cards for all of the TSPs.

8.5 Early Warning Systems

The NETP (NETP 2013, Annex 4.10, pp 128) discusses the early warning connectivity flow. SMS and Email are most popular for exchanging early warnings. Use of social media such as the posting of meteorological and hydrological warnings on Facebook are also common. Television and Radio are the broadcast media used in Nepal. Citing LIRNEasia's research in the Maldives (NETP 2013, Box 5.4 pp 55), NETP has recommends the use of Cell Broadcast in early warning disseminations. However, is yet to be implemented.

[25] SASEC network was approved in 2007. Consulted 2016 March 03 on the www: http://sasec.asia/index.php?page=project&pid=66&url=sasec-information-highway-project-bangladesh-bhutan-india-nepal

8.5.1 Department of Hydrology and Meteorology

The Department of Hydrology and Meteorology (DHM) Office at the Kathmandu Airport was damaged. They had to relocate to an office near Naga Pokari. After the earthquake, the airport and DHM lost Internet. All their warning services became useless for, at least, two days. The DHM is considering a establishing a Disaster Recovery Center; possibly in partnership with the NITC.

June and July monsoon rains bring in a lot of precipitation to the mid-range mountains. There are 7 rivers that cause major floods every 2-3 years. 200-300 lives and property continue to be lost each year. This i indicates that there is a need for improvements in the warning systems. In 2014, five districts lost 400-500 people. Landslides cause river flooding that inundate villages and destroy livelihoods. Approximately 3,000 landslides have been reported between 12th May and 15th May alone.

Nepal has over 660 river systems. The DHM has setup a sensor network with 27 nodes and is expanding that to 200 over the next five years. Glacier Lake Outburst Floods (GLOFs) are an imminent threat. There are 45 automatic weather stations in the mountains to monitor severe weather.

DHM is building a sensor and location-based warning network that would forewarn exposed populations and other relevant systems. The warnings are relayed through redundant CMDA and GSM channels. Given the unreliabilities, the systems uses multiple TSPs to connect the detection/monitoring stations. The same commercial TSP networks are used to relay SMS, Email, and Web alerts to decision-makers and relevant focal points.

8.5.2 Tourism and Transient Populations

Transient populations are of two kinds: local migrant workers who travel to Kathmandu for seasonal work and the tourists. Alerting trekkers in the mountains is challenging. Not all guides carry VHF radios. GSM coverage with only 2G voice is still rather scarce in many mountainous areas. Alerting Authorities should work with Environment and Tourism Authorities to warn transient populations.

The Department of Tourism is introducing a magnetic flashcard at various checkpoints on the trails to monitor each trekker's last reported location. The tracking database would aid SAR efforts during a crisis. At present the Department issue paper-based Tourist Information Management System (TIMS) trekking permit that serves as an identification, with photo. The TIMS data is recorded the conservation area entrance, exit, and at various mountain police posts.

Although Nepal is landlocked, it was severely affected by the Hudhud tropical cyclone in the October of 2014[26]. The winds and precipitation was equivalent to that of a severe weather winter storm. Forty Three trekkers, in the Pokhara recreational area, died from the storm that descended on them without prior notice. The difficulties of warning transient populations is always a challenge. Designing and deploying all-hazards systems, suitable for a wide range of events (or incidents) and multi-stakeholder approach, would better prepare the Nation to respond to such surprised situations.

8.5.3 Red Cross warnings system

International Federation of Red Cross and Red Crescent (IFRC) society in Nepal is experimenting with a location based multi-casting warning system for their society members. IFRC is working with NT and NCell. The TSPs are providing IFRC with a monthly update of their HLR data. IFRC routines use the HLR data to update the location and member specific data. The warning messages are pushed through SMS.

8.6 Incident Management

8.6.1 Emergency Operation Centers

The primary activity of the NEOC after the earthquake was to consolidate information received through various Government and Non-Governmental Organizations. Each Ministry was assigned to a District to report the data and assist with the relief efforts. The Chief District Officer of Government is also the head of the District Emergency Operation Center (DEOC).

[26] Wikipedia report on Tropical Cyclone Hudhud and Nepal death toll. Consulted 2016 March 03 on the www: https://en.wikipedia.org/wiki/Cyclone_Hudhud#Nepal

Currently the EOC is supporting the Nepal Emergency Communications Cluster (consitutes members of the Nepal ETC). The goals of the cluster are to improve the voice and data services in support of emergency communications and disaster management. There might be an overlap of roles of responsibilities between the NEOC governed Emergency Communications Cluster and the parallel group recommended in the NETCOMM.

The NEOC is one of the focal points of the DHM early warning system. NEOC has a dashboard display of all the monitoring stations that send color coded messages. Alarming events are relayed to the NEOC network of first-responder though FAX and VHF radio transmissions.

NEOC has recently deployed the Sahana software for managing their situation, facilities, and response information. The NEOC needs IT to manage the ongoing Disaster Risk Reduction (DRR) projects. They could extend the Sahana software for managing DRR projects[27].

8.6.2 Nepal Police and Armed Police

The Police forces in Nepal constitutes the Nepal Police and the Armed Police. Nepal Police is in charge of civil matters and the Armed Police is responsible for border control, terrorism, and related activities. Both units have an Information Technology (IT) and Telecommunications division.

HF and VHF, using cross-band technology, remains to be the most popular and preferred mode of communication by Nepal Police and Armed Police. ICTs are slowly taking precedence and are being integrated into the daily communication practices. Realizing the value of VHF/HF MoICT has allocated two emergency frequencies to the United Nations (UN) and the three to the Nepal Police.

Nepal Police statistics indicate that Person Location Finding Requests came to them were 50% from Facebook, 29% from Twitter, and 21% from SMS. The 'missing persons' registry' and the 'daily incident report' are two national systems. These two systems are not fully computerized. Police Headquarters and selected Districts are interconnected. Rest of the Police Stations document on paper and report summaries over VHF.

[27] DRR Project Portal, Asia-Pacific tool for effective DRR planning, ADB, ISDR, ADPC Asia Partnership. Consulted 2016 January 10 on the www: http://www.drrprojects.net/

The Metro-Police, in Kathmandu, operates a Computer Aided Dispatch (CAD) system. All emergency calls received through the short codes 101, 102, 103, and 104 are routed to the Dispatch Unit. Although the short codes are designated for the different emergency services, they are received at the central dispatch service, as it should, and then the calls are routed to the police, fire, and ambulatory services as per the situation.

The CAD is integrated with the Incident Management system. Both the CAD and the Incident Management system utilize the Kathmandu metropolitan area geocodes to geospatially map the incidents. The Kathmandu Metropolitan City Office is the advocate responsible for introducing geocodes to the Kathmandu metropolitan area.

A new introduction is the "Hamro Police[28]" Android and Apple mobile application for the public to interact with Nepal Police. Few of the police vehicles are fitted with GPS devices for tracking. However, maintaining those GPS devices are a concern.

NT and NCell TSPs have set up caller groups to support the different police communication requirements. For example, the traffic police is one group. Two providers serve as a failsafe mechanism. That is, if one does not work then the other is used. They are able to send bulk text messages to targeted police groups through these caller groups.

The police communicate with the public through Radio and TV. A dedicated radio channel is used to advise the public regarding traffic. The same radio channel, is also used during emergencies to warn the public and to inform of any actions to be taken. Facebook and Twitter have been effective media for interacting with the Nepali citizens.

8.7 Efficacy of Regulating Standards

The NTA's TSP licenses do not provide any service level agreement clause in support of emergency communications. A concern raised by NTA was, even with the inclusion of a clauses, whether it would be possible to regulate. The broadband policy and ICT policy documents refer to clauses that support emergency communication and disaster management.

[28] Hamro Police mobile application launched in Kathmandu Metropolitan area police can be downloaded from the AppStore. Consulted 2015 Dec 23 on the www: http://appshopper.com/utilities/hamro-police

For example, in 2012 there was a telecommunications policy that required TSPs to seek authorization from a committee, if the tower height exceeded 9 meters. The constraint is that the designated committee meets twice a year. The TSPs would not have the patience to wait for such a long period of time. The TSPs simply ignore those regulations to build telecommunications towers at their own discretion. Setting standards involves an authorization process leading to more bureaucracy. Guidelines with best-practices, over standards, are the preferred choice.

9 RECOMMENDATIONS

9.1 The Nepal Context

The 2013 Final Report on NETP and the NETP framework (NETCOM 2015) discusses goals and actions in a broader perspective. The recommendation, discussed in the subsequent sections, complement the NETP. As a result we have discussed several recommended goals and activities that would address the NETP objectives.

Based on the synthesis of the lessons learned from the earthquake experience and the general state of emergency communications in Nepal, the report has identified three key recommendations. These recommendations seek to improve the crisis and emergency management systems in Nepal and complement the NETP (see Table 1).

Implementing such recommendations have policy and legal implications. However, this report does not discuss those implications. Instead, if GoNP and other stakeholders decide to accept and work towards implementing these recommendations, then they might consider carrying out a series of pilots to determine the policy and legal requirements.

9.2 The Three Key Goals

The three key goals, listed in Box 2, follow a natural sequence. Designers and developers of Nepal's emergency communication systems might consider following them. The first goal: (I) assessment of telecommunications availability and survivability would determine the emergency communication systems' (application, network, and physical components) extreme vulnerabilities. Some vulnerabilities can be mitigated through investments in strengthening the robustness. Other vulnerabilities would require a RREACT program.

When the networks are affected by a hazard event, they must be restored to resume the information flows. The second goal: (II) RREACT program should be designed for the CASA/ICCS information exchange platforms to seamlessly communicate with first-responders on the scene. Further to serving the emergency services, the RREACT program should be prepared to provide the public with access to telecommunications for their crisis and emergency communications needs.

Box 2: Recommended Goals to complement the NETP

I. Telecommunications Availability and Survivability Assessment using the risk mapping and step-wise refinement methods to gather evidence in support of a robust GECO network and BC-DRP framework

II. RREACT program to provide communications interconnection, access points (hot-spots) and back-haul for voice and data using useful and easy to use communications technologies

III. CASA and ICCS platforms for all-hazard all-media warning, incident management with CAD, and a common operating picture for improving institutional responsiveness to all-hazards

The third goal: (III) CASA and ICCS provides the application layer and relevant communication components for managing and exchanging crisis and emergency information with all stakeholders (NETCOM, pp 8). The CASA and ICCS are heavily dependent on uninterrupted telecommunications. Therefore, goal (I) and goal (II) are important elements of fault tolerant information systems.

9.3 Recommended Goal (I): Assessment of Telecom Resilience

9.3.1 Rationale

It was found that the recent earthquake destabilized the already fragile landscape in many parts of the mountains, while in some places deep fissures developed (REA 2015, pp 6). These sites can bring landslides anytime, especially those triggered by the monsoons. In the rocky terrain fiber optic cables are not buried but strung on poles. These are vulnerable to

avalanches and rock slides.

Lightning and landslides are common hazards in Nepal. Other natural threats involve floods, forest fires, and drought. Cables are often destroyed by fires started by people. There is a need to develop contingency plans. Regulators should be aware of the nature and depth of such vulnerabilities in emergency telecommunications infrastructure. Such knowledge would help shape the BC-DRP as well.

Engineers who were dispatched to restore telecommunications in certain areas could not access those locations by road. Other engineers were trapped in their own home towns unable to communicate with their office or join the restoration teams. Often TSPs only consider contingencies from an engineering perspective and ignore the human and other dependent factors. In most situations the BC-DRPs are formulated and never rehearsed or they are rehearsed under perfect conditions, which reduces the ability to appreciate the practical problems.

The Nepal Police depends on NT and NCell Telcos to provide them with the communications they need for alerting police officers and receiving incident reports. On the day of the earthquake NT and NCell services were dysfunctional. Nepal Police was limited to their VHF and HF radios for communication. The example, is one of many where emergency services rely on critical telecommunications infrastructure to support their telephony and data services. Often emergency services presume perfect resilience of the dependent systems. There is a need for emergency response organizations to validate the survivability and availability of those dependent systems.

The Nepali Telcos have expressed their appreciation and need for a set of best-practices with for building resilient critical infrastructure. For example the Telcos were keen to know, before hand, how one might quickly build a shelter, with available materials, to secure the outdoor hardware. Such protocols are not necessarily telecommunications engineering practices but more so inclined towards civil engineering.

9.3.2 Objectives

1. Establish a institutional capacity at all levels of public and private sectors, in assessing and mitigating risks to their communication systems

2. Establish a participatory approach to evaluating the survivability and availability of emergency communications for a robust GECO
3. Establish a mechanisms for TSPs, Emergency Services, and other relevant stakeholders to strengthen their own BC-DRPs
4. Establish a set of emergency telecommunications infrastructure construction and operational best-practices supportive of national emergency communication resilience

9.3.3 Actions

Box 3: Recommended actions for emergency communications resilience

(a) Train a set of Trainers in applying the telecommunications availability and survivability assessment method that fosters Emergency Services in determining their ICT resilience and to develop mitigation strategies

(b) Train a set of trainers, with BC-DRP development guidelines, to assist TSPs and Emergency Services in adopting and developing their own programs that complement the Nation's expectations

(c) Analyze earthquake data and study regional best-practices to draw policy relevant evidence in support of setting infrastructure building and restoration guidelines for resilient emergency telecommunications

9.3.3.1 Action (I.a): Build Capacity to Assess Telecom Resilience

Emergency communication system availability and survivability are important elements of a robust GECO and for public communication during crises and emergencies. For such there are four components that the capacity building program might consider in the given sequence:

i) Build capacity to conduct participatory appraisals to determine the tripartite mapping of the perception of risk to the required information, and eventually to deploy information communication technology to optimize complementary redundancy
ii) Build capacity to conduct GIS-based risk mapping and coverage mapping of existing emergency communication networks to determine the survivability and availability

iii) Build capacity to conduct a participatory Risk Assessment by Stepwise Refinement (RASTER[29]) to improve emergency communication system survivability and availability

iv) Build capacity to conduct a topology generated analysis, simulation, and experimental emulation techniques to determine the infrastructure survivability[30]

9.3.3.2 Action (I.b): Build capacity to develop Institutional BC-DRPs

The BC-DRP should satisfy that TSPs and Emergency Managers have taken all factors into account and that communication links of a "mission-critical" nature have been properly identified, afforded appropriate protection (e.g., priority network access, separation of incoming/outgoing traffic, more than one power source, connection to more than one switch or exchange, priority fault repair) and where necessary, alternative stand-by links on separate systems (electronic and/or physical) are kept immediately available. Clearly staff who may have to use alternative systems need to be practiced in their use. For such there are four components that the capacity building program should consider in the given sequence:

i) Build capacity to conduct a comprehensive needs and gap analysis of the current state of BC-DR practices of emergency telecommunication and crisis and emergency management organizations.

ii) Build capacity to utilize the evidence from the needs and gap-analysis to custom design an institutional BC-DRP training program for the emergency telecommunication and crisis and emergency management organizations.

iii) Build capacity to develop BC-DRP implementation guidelines for emergency telecommunication and crisis and emergency management organizations to adopt

iv) Build capacity to develop BC-DRP evaluation guidelines for regulatory authorities to assess and Organizations to self-assess the robustness of the BC-DRP programs at the National and Local Institutional layers

[29] RASTER methodology designed for stakeholders to collaboratively determine the vulnerabilities and impact and then mitigate the consequences. Consulted 2014 October 10 on the www: http://www.utwente.nl/ewi/is/research/raster/

[30] Evaluation of network resilience, survivability, and disruption tolerance: analysis, generation, simulation, and experimentation, invited paper published in Telecommunication Systems by James Sterbenz, Egemen Cetinkaya, Mahmood Hameed, Abdul Jabar, Shi Qian, and Justin Roher

9.3.3.3 Action (I.c): Develop infrastructure build-n-restore best-practices

Strategic investments on resilient infrastructure pays of during the time of a crisis. GoNP might consider establishing a set of guidelines for building resilient BTS, transmissions, and telecom buildings as well as guidelines for rapid restoration of the three elements.

i) Gather evidence from the resent Nepal earthquake and analyze the information to identify the shortcomings to be presented in the form of a lessons learned report

ii) Study the Japanese Ministry of Internal Affairs and Communications[31], Korean Government smart grid project[32], The Indian National Disaster Management Authority[33] , Sri Lankan Telecommunications Regulatory Commission[34] published guidelines on “disaster resilient construction of buildings and infrastructure that discusses the precautions communications developers might consider when building infrastructure.

iii) Combining the lessons from the earthquake and the regional best-practices study to formulate a set of policies and guidelines that would support the infrastructure resilience and rapid restoration in support of crisis and emergency communications.

9.3.4 Expected Outcomes

The resilience assessment exercise would assist GoNP with visually assessing the eminent risks to the assets; i.e. emergency communication infrastructure and personnel. Thereafter, be able to introduce guidelines, policies, and SOPs to improve the resilience. The guidelines would involve geographic area, hazard, and vulnerability specific infrastructure construction best-practices and BC-DRP guidelines. Policies would assist GoNP with enforcing the guidelines. Guidelines should also define methods to evaluate the stakeholders for their resilience based on Key Performance Indicators (KPIs).

[31] Kobayashi, M. 2014. Experience of Infrastructure Damage Caused by the Great East Japan Earthquake and Countermeasures against Future Disasters. IEEE Communications Magazine: http://tinyurl.com/grsfheo

[32] GSMA Intelligence (2012). South Korea: Jeju Island Smart Grid Test-Bed. Consulted 2015 March 02 on the www: http://www.gsma.com/connectedliving/wp-content/uploads/2012/09/cl_jeju_09_121.pdf

[33] National Disaster Management Guidelines On Ensuring Disaster Resilient Construction of Building and Infrastructure financed through Banks and Other Lending Agencies, published on 2010 September. Consulted 2014 December 10, on the www: http://ndma.gov.in/images/reports/ENFDMA120511.pdf

[34] TRCSL guidelines on antenna structures. Consulted 2015 July 09 on the www: http://www.trc.gov.lk/images/pdf/guide_l.pdf

A subsequent outcome of the resilience assessment exercises is gaining insights for strategically developing the RREACT program. The information would also determine where to best position redundant equipment and trained personnel. It would also provide insights on the best design strategies for Nepali city, urban, and rural communications networks. For example, buried fiber cable is proven to be robust; where such design strategies can be exercised in cities. Microwave is economical to connect villages, distant, but across each other with a clear line of site, on adjacent mountain slopes.

Identifying areas where microwave can be replaced with fiber improves resilience in manifolds. One critical aspect is the need for tall rooftop antennas to hoist the point-to-point microwave link. The cell antennas, connecting to the mobile devices, can be at a lot lower height. Moreover, the the amount of electricity required to power microwave transmissions opposed to fiber is relatively higher. Hence, the number of backup batteries required to power the transmission is less, removing all that weight from the structures.

The BC-DRP capacity building initiative will bring awareness into all the stakeholders of the real need for developing Institutional BC-DRP capacity at the National and Local layers. These initiatives would complement the framework proposed in the NETCOMS document. Implementation and evaluation of the Institutional BC-DRP programs would reduce the mean time to failure of emergency communication and crisis and emergency response services.

The BC-DRP capacity building program would also foster GoNP with developing model plans and procedures to institutionalize a BC-DRP with measurable KPIs driven certification process. Exercising BC-DRP KPIs would ensure security and reliability of the emergency communication systems. Part of the KPI evaluation would involve periodic rehearsal of the BC-DRP for the rapid restoration of the shared critical infrastructure and services. Thus the KPIs would bring meaning to the drills and simulations prescribed in the NETP.

9.4 Recommended Goal (II): Develop a RREACT Program

9.4.1 Rationale

The earliest that the TSPs could restore 40% of the damaged services was after two days. It took over a week to restore 100% of the services. The public and emergency services were unable to effectively utilize the commercial telecommunications. Public have an inherent need

to stay connected and emergencies alleviates those needs. Nepal Police has established emergency communication protocols that depend on the use of NT and NCell implemented caller groups.

The SmartTel TSP transmissions were depending on ISP transmission lines. The ISPs were also leasing NEA optical fiber. When the transmission lines failed all dependent service came to a stand-still. The emergency services were depending on the commercial telecommunications to serve their voice and data communication needs. A focus group of ITU-T study group 2 emphasize that “network resilience and recovery depends on a highly reliable network design, such as a multiple network route. For emergency telecommunications it is useful to establish temporary telephone services by temporarily restoring damaged mobile base stations after a disaster[35]”.

LIRNEasia report on “building e-resilience[36]” recommends governments to establish policies that outline the chain of command and activating SOPs. These policies must emphasize on deploying first-responders to establish telecommunications continuity in support of saving lives and relief operations. Rehearsing the SOPs and revising them regularly is important. One suggested plan was to make use of 'earthquake day” for such activities. Nepal Police and Armed Police have well established SOPs.

All stakeholders responsible for the continuity of emergency communication services should learn from the Police and leverage their expertise to be better prepared with response plans. For example, because of the daily tremblors, the first reaction of the Police Units were to move their communications units to an open space and continue their operations outdoors.

9.4.2 Objectives

1. Establish a national program capable of restoring access to telecommunications in support of a seamless GECO system
2. Establish strategies and a framework for fostering a platform that would involve public and private participation in developing ways and means for ensuring seamless public

[35] Overview of Disaster Relief Systems, Network Resilience and Recovery (DR&NRR), published May 2014, International Telecommunication Union Standardization Sector, Focus Group DR&NRR, Study Group 2. Consulted 2014 October 14 on the www: http://www.itu.int/en/ITU-T/focusgroups/drnrr/Pages/default.aspx

[36] Building e-Resilience: Enhancing the role of ICTs in DRM (2015) by Shazna Zuhyle, Sriganesh Lokanathan, Laleema Senanayake, and Ransimala Weerasooriya, LIRNEasia report prepared for UNESCAP.

access to telecommunications during crises and emergencies

3. Establish SOPs and guidelines for integrating all entities that can provide and share their communications.

9.4.3 Actions

Box 4: Recommended actions for a RREACT program

(a) Build a mobile communications truck to support interconnecting any kind of voice or data technology for emergency services, dispatch centers, and EOCs to coordinate events

(b) Build grab-n-go kits for the rapid restoration of voice and data access points and electricity in any part of Nepal

9.4.3.1 Action (II.a): Build a Mobile Communications Truck

A Mobile Communications Truck (MOCOT) would be designed to serve as an interconnection point that crisis and emergency response teams, working in the field, could interconnect with the decision support systems at the central EOC for sending and receiving mission critical information. It would also be equipped to serve as a mobile command and control center.

i) Develop blueprints through a research and development process, based on evidence from the earthquake and other events, to build a MOCOT for the Nepal context

ii) Develop a MOCOT that can reach any urban and rural area to drive in rugged terrains in Nepal (consider air transportation for rapid transportation)

iii) Develop a MOCOT with redundant back-haul capacity that can interconnect through available satellite and terrestrial communications

iv) Develop a MOCOT that serves as an interconnect communications hub between all exercised communications spectrum: WiMax (2.4 GHz & 5.08 GHz), LTE (450 MHz & 700 MHz), UHF, VHF, HF, GSM/WCDMA.

v) Develop a MOCOT that would support communications for a mobile EOC aiding crisis and emergency responders in the field

vi) Develop a MOCOT that would be used in training and drills for crises and emergencies serving all emergency responders: Emergency Medicine, SAR, Police, Fire, Military and other relevant authorities.

9.4.3.2 Action (II.b): Develop Grab and Go Kits

The MOCOT predominantly serves as an interconnection point and a transmissions hub. The grab-n-go kits would complement the MOCOT with turnkey access points and power hubs. The grab-n-go access points could connect to the MOCOT or to existing functioning communications. These are self-contained units that have their own power sources.

i) Develop a set of requirements based on the earthquake and experience from other events to design a necessary and sufficient set of grab-n-go kits

ii) Develop a set of grab-n-go kits, applying a research and development strategy, that are easy to use and affordable utilizing already operational technologies: WiMax (2.4 GHz & 5 GHz), LTE (450 MHz & 700 MHz), GSM/WCDMA, UHF, VHF, HF.

iii) Develop protocols for differentiating kits and deployments that are for crisis and emergency responders and ones that are for public to avoid the public from congesting the channels used by the crisis and emergency responders

iv) Develop a training and maintenance program for deploying the grab-n-go kits at short notice and frequently testing them to be on stand-by and ready to operationalize mode

v) Develop operating procedures considering requirements for coordinating with the entities, such as aviation services, that would provide assistance with rapid deployment

vi) Develop a registry of entities that the program would support with telecommunications assistance and involve these entities in periodic drills to improve the performance.

9.4.4 Expected Outcomes

COWs are designed to serve as a BTS. However, the MOCOT's utility would serve beyond what a typical COW offers. For example, a forest fire in an area deficient of terrestrial communications coverage would utilize the MOCOT. It would interconnect the fire firefighters talking on VHF handsets with the central EOC VoIP telephones. Feeds from fire fighter helmet mounted cameras could be seen at the EOC.

Developing the MOCOT would serve as a research and development activity. Experts thinking through the design and using the vehicle to test various telemetries of the technologies under Nepali conditions are valuable learnings. One option is to begin with the already received COW from Huawei. Expand on that or transfer that knowledge to a more homegrown utility vehicle. This would provide insights towards a more robust design and program suitable for Nepal. Northern India, Bhutan, Northern Pakistan, to name a few, are countries with similar geographical characteristics. Lessons learned can be shared with them.

There is a distinction between restoring public telecommunications and first-responder telecommunications. Connecting general public over critical networks reserved for emergency managers would congest them. Differentiating the public networks from emergency communications is a primary categorization. Given that the Government of Nepal's primary concern is with strengthening the response and warning networks this report would be consider the Government, NGO, Private Sector, and Public communication needs

Maintaining a registry of all available communications would be instrumental in requesting assistance from other entities. For example, the HAM radio society of Nepal is a 52 member strong team. There are 3 VHF sets operated by the hospital and ambulance. The registry would complement the objectives outlined in the agreement signed by the South Asian Association for Regional Cooperation (SAARC), in 2011, member states to support and strengthen existing instruments for rapid response in the region.

It is easy for MOCOT and grab-n-go kits to deteriorate if they are unused. Incorporating the hardware and personnel in training programs to bring awareness to the public and institutions, at the local layers, is one opportunity to maintain the use of the equipment. Moreover, it serves a dual purpose of advocating awareness and training, much needed in for better preparedness. Other activities might involve participating in regional and international simulation exercises.

Frequent tests and exercises involving all relevant agencies, is important, Silent-tests for system diagnostics can be more frequently executed (e.g., once a month). Live-exercises involving stakeholder participation can be limited to perhaps once or twice a year. Integrating these as part of the RREACT program would improve the resilience of emergency communications in Nepal.

9.5 Recommended Goal (III): Multi-Agency Situational-Awareness

9.5.1 Rationale

MoHA appointed Chief District Officers, and DEOCs to provide leadership to the earthquake response efforts. The National Police, Armed Police, and Military, in the Districts, were supporting the DEOCs. There was no common operating picture to coordinate the response. USA, Chinese, and other Foreign SAR teams were reluctant to enter or dig into partially collapsed buildings without knowing the structural engineering plans. The frequent after-shocks amplified the fear.
Open data can be effective in such situations.

There is a need to build ICT applications that can be used everyday and make the public aware of those to utilize during any emergency. It is perceived that Nepalese Government is unaware of best practices for utilizing ICTs in disaster and emergencies. Open Source software and new media can be effective when properly utilized. Nepal police established Twitter channel is proof of how IT can be effective in crisis response and management. Situational-awareness is an important element for efficiently coordinating response. The QuakeMap hosted by KLL is an example of platform that can share the mapping incident report. However, these are single purpose applications.

What the GoNP might consider is an integrated IT system that serves the full gamut of emergency and disaster management information needs. GoNP's efforts to operationalize the comprehensive Sahana disaster management sytem, to serve their information needs in managing the Gorkha earthquake SAR, relief, and recovery efforts was cumbersome. Such systems are effective if they are operationalized before a crisis. There is some initiative of NEOC to adopt the Sahana system[37]. GoNP might consider adopting such versatile IT systems in a broader perspective by integrating them into their daily emergency management practices opposed to serving as a one-off crisis response.

[37] The NEOC hosted Sahana instance. Consulted 2016 March 04 on the www: http://sahana.neoc.gov.np/sahana

9.5.2 Objectives

1. Establish a multi-agency situational-awareness platform to integrate all alerting authorities and emergency response organizations, at national and local layers, with a common operating picture to improve institutional responsiveness
2. Establish a multi-agency first-response platform (i.e. incident management system) to integrate all emergency response organizations, at national and local layers, with situational-reporting procedures for improving response coordination and management
3. Establish interoperability standards to integrate all crisis and emergency MIS with national and international systems

9.5.3 Action Items

Box 5: Recommended actions to improve institutional responsiveness

(a) Conduct an awareness workshop that employs software tools, interoperability, and operating procedures for risk mapping in support of impact-based waring, managing a register of alerting authorities, all-hazards all-media warnings, dispatch and incident management

(b) Pilot-test an all-hazard all-media CASA platform for alert/warning and integrating the publishers and subscribers through the EDXL-CAP enabled interoperable data standard and related policies/procedures.

(c) Pilot-test an Incident Reporting and an ICCS for coordinating small and large scale crisis by considering the EDXL-SITREP and EDXL-RM interoperability standards and related policies/procedures.

9.5.3.1 Action (III.a): Develop a CASA & ICCS implementation plan

The uptake of integrated CASA and ICCS practices in low and middle income countries in Asian are weak. It is starting gain momentum through projects advocated by the UNESCAP[38]. GoNP might consider adopting CASA practices through a unified process through iterative and incremental developments. GoNP might consider the following actions:

[38] Improving coastal resilience through multi-agency situational-awareness project funded by UNESCAP trust fund for tsunami, disaster, and climate change: https://sahanafoundation.org/cap-on-a-map-kickoff/

i) Sponsor a CASA and ICCS awareness workshop through a participatory and collaborative approach that would organize hands on training and exposure to tools and methods for realizing the potential and applicability of the systems to Nepal

ii) Identify key National and International partners with a vested interest in developing sponsoring the development of a proposal to pilot the CASA and ICCS concepts in Nepal

iii) Seek resources to pilot-test the CASA and ICCS concept with an intention of gathering evidence on the technical, cultural, social, policy, and legal dimensions for operationalizing the systems in Nepal

9.5.3.2 Action (IIII.b): Pilot-test an EDXL-CAP-enabled platform

The DHM experience on early warning systems is being transferred into other areas with a multi-hazard early warning approach. Besides developing the monitoring and detection systems for each of those hazards, a challenge would be with interconnecting the various crisis and emergency responder communication systems for shared situational-awareness.

i) Participate in an EDXL-CAP Implementation Workshop[39], typically co-sponsored by WMO, ITU, OASIS, and IFRC to realize the utility and use of EDXL-CAP in National and International warning systems

ii) Organize an EDXL-CAP implementation training of trainer workshop that provides hands on training on the EDXL-CAP standard and procedures using software tools for building capacity in Nepal

iii) Pilot-test an EDXL-CAP-enabled software system[40] that allows for initiating an interoperable CASA platform for all-hazards all-media alerting and warnings

iv) Gather evidence from the pilot-study to introduce policies for scaling the implementation nation-wide to improve Nepal's responsiveness to hazard events

[39] A list of past CAP Implementation Workshops. Consulted 2016 Feb 10 on the www: http://www.wmo.int/pages/prog/amp/pwsp/CommonAlertingProtocol_en.html

[40] Sahana Alerting and Messaging Broker (SAMBRO) is an EDXl-CAP-enabled comprehensive software for managing the publication of alerts and warning, subscription of closed user group and public alerting, and all-media dissemination. Consulted 2016 December 12 on the www: http://eden.sahanafoundation.org/wiki/Deployments/SAMBRO

9.5.3.3 Action (III.c): Pilot-test an EDXL-SITREP/RM-enabled ICCS

An ICCS would integrate crisis and emergency response services to better coordinate actions and remove duplication. Given that the Nepal Police have an institutionalized ICCS, they would serve as an ideal candidate to take the lead in implementing an integrated multi-agency ICCS, one that can be used by NEOC and DEOCs during crises.

The Federal Emergency Management Agency (FEMA) offered ICS course is quite comprehensive but complex. It is designed to handle every aspect of a national incident management system. Nepal might consider a simplified ICS that allows for situational-reporting and resource messaging.

i) Organize an implementation training of trainer workshop to provide hands on training with the use of EDXL-SITREP and EDXL-RM standard and procedures using software tools

ii) Pilot-test an EDXL-SITRP and EDXL-RM compliant software system that allows for initiating an interoperable ICCS integrating multiple crisis and emergency response agencies; specifically Nepal Police, Armed Police, Emergency Medicine, Fire Department, NEOC, and DEOCs.

iii) Gather evidence from the pilot-study to introduce policies for scaling the implementation nation-wide to improve Nepal's responsiveness to hazard events

9.5.4 Expected Outcomes

Nations that have implemented the EDXL-CAP interoperable content standard have been successful in integrating their warning systems with all National and International warning systems. It allows for integrating all Alerting Authorities at all layers of the administrative system and ease of scaling. A CAP-enabled messaging broker with a common operating picture can improve coordination of alerting and warnings among all response agencies. Moreover, GoNP would be able to leverage the free services offered by Google Alert Hub[41], Federation of Internet Alerts[42], WMO Alert Hub, and any other EDXL-CAP-enabled services.

[41] Google Crisis Response offers an alert hub for validating EDXL-CAP messages and publishing them on their Alert Hub. Those alerts issued by National Alerting Authorities are displayed on Google products: www.google.org/publicalerts

[42] Federation of Internet Alerts (FIA) is a consortium of on-line advertising agencies that have offered to public

The EDXL-SITREP and EDXL-RM content standards are designed to support the management cycle of reporting incidents, deriving the required response, and dispatching those services. It streamlines the process allowing disparate systems to collaborate on a common platform. For example, the fire department may have their own incident management system with endemic protocols and the police their own. However, if systems are EDXL-SITREP and EDXL-RM compliant then it is easy for them to exchange information. Moreover, they are able to coordinate using a common operating picture.

While the great earthquake may come every century the CASA platform and ICCS can be used in daily occurring events. Nepal Police, Ambulatory Services, and Fire Department can share the the ICCS to report and manage incidents. Meteorological Services, Public Health, Agriculture, Tourism, and other Alerting Authorities can use the CASA platform for disseminating alerts. Both the CASA and ICCS would interlink to share a common operating picture of prevailing situations with all relevant stakeholders at the national and local institutional layers. Since the systems are always on and always operational, they will be ready to use during crises such as major flooding, landslides, forest fires, and drought that threaten the lives and livelihoods of Nepal.

10 CONCLUSION

Nepal's emergency communications, for saving lives and effectively supporting relief operations, is a development priority, if the country is to avoid similar setbacks during future disasters. Lessons learned, from the post Nepal earthquake field mission, points to a growing need for investments in building institutional capacity, national programs and policies to increase the uptake and strengthen the resilience of ICTs for effective disaster risk management.

The findings indicate that the level of communications resilience does not meet the expectations; especially when it took over 2 days to restore 40% of the damaged telecommunications. A significantly large number of BTS were down 48 hours after they exhausted their fuel to generate electricity. TSPs are interconnected with other service providers, such as the power and back-haul transmission suppliers. Institutions are unprepared and are lacking properly planned and exercised BC-DRPs and SOPs. In the same way that challenges to infrastructure must be addressed to enable access to remote

alerts issued by National Alerting Authorities on their on-line ad spaces. Consulted 2015 January 11 on the www: www.internetalerts.org

sites, resilience of communication providers will require resilience to be built into the institutions which support them. There is a need for shared information platforms and a common operating picture for improving institutional responsiveness to crises and emergencies.

While the recommendations complement the GoNP's NETP (discussed in Table 1), they also complement the Sendai Framework for Disaster Risk Reduction 2015-2030. The key recommendations: telecommunications availability/survivability assessment, BC-DRP capacity development, institutionalizing a RREACT program, and implementing a CASA/ICCS, are directly related to the four key elements of the Sendai Framework: “understanding the risk”, “strengthening disaster risk governance”, “investing on disaster risk reduction, and “enhancing disaster preparedness”, respectively.

Achieving these recommendations require a multi-sectoral multi-stakeholder collaborative approach. The MOICT, MOHA, and NTA might consider leading the Nepal ETC in planning and executing the recommended activities. Such an investment would remove the tensions and complexities in the organizational practices and bring coherence to crisis and emergency communication. A challenge that the GoNP might foresee are the resource investments. The Paris agreement on climate change, signed by 195 countries, pledged a large volume of financial support to developing countries to help them improve their systems. Nepal should not miss such opportunities.