International Journal of Information Technology and Business Management
29th January 2017. Vol.56 No.1

ISSN 2304-0777 www.jitbm.com

ANALYSIS OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN THE MANAGEMENT OF CLIMATE CHANGE IMPACTS IN UGANDA

John F. Magolo, Benon C. Basheka and Epiphany O. Picho

Abstract.

Well-tested and implemented Information and Communication Technologies (ICTs) can and should be an integral part of climate change impacts management (mitigation, preparedness, response, and rehabilitation). ICTs can play an important role in the collection, retrieval, dissemination, and storage of information, to ensure that it is available to those who need it, at the time and place it is needed. However, access to adequate infrastructure is a prerequisite for the adoption and use of ICTs in risk reduction and disaster response coordination. The implementation of ICTs for climate change impacts management in Uganda is uneven among regions, and the lack of access to modern and up-to-date ICT infrastructure has severely hampered the effectiveness of a disaster management authority to competently respond to identified hazards. This therefore calls for increase in the amount of ICT infrastructure information gathering, hazard and vulnerability assessments, early warning alerting, quick response capability, and the coordination of rehabilitation activities both locally and nationally.

Keywords: Information and Communications Technology (ICT); Climate Change Impacts (CCI); Management

Introduction

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

Climatic changes leading to disasters have been more frequent than ever. Disaster occurrences cannot be eliminated, but they can be better managed. The successful management of emergency situations requires proper planning, guided response, and well-coordinated efforts across the disaster management life cycle. Information and Communication Technologies (ICTs) can be used to support the practice of CCI management in times of planning, crisis and reconstruction. The potential of ICTs lies in their ability to instantaneously connect vast networks of individuals and organizations across great geographic distances, and to facilitate fast flows of information, capital, ideas, people and products. ICTs have become essential tools for cooperation and collaboration that is enabled through detection and analysis of dangers. At detection, ICTs propagate early warning messages to populations, and enables coordination and tracking of relief activities as well as resources, records acquisition and management as well as dissemination of knowledge and experiences and awareness creation (Williams and Phillips 2014)

The overall goal of CCI management is to keep humanitarian, socio-economic and environmental losses as low as possible. The management of information is foundational in the effort to achieve this goal, specifically: maps and data concerning the territory, information on hazard types, probabilities and timelines, protocols for emergency

ISSN 2304-0777 www.jitbm.com

communications, and instructions on actions to be taken prior, during and after the impact of a hazard. The efficiency of humanitarian responses to a disaster and the number of lives saved is directly related to the ability of an organization to compile, analyze, and distribute information (PAHO, 2005). Stolzenburg (2007) argued that existence of information alone is not enough to ensure its effective dissemination. The possessors of the information must know what to do with it, and there must be appropriate governance systems to act on the information at the receiver's end.

Well-tested and implemented ICT-based knowledge management systems can help to decide what developments to monitor, what decisions to focus on, and what processes can be set in motion automatically, or in advance of an impending hazard. Knowledge management systems facilitate the collection, retrieval, dissemination, and storage of information, to ensure that it is available to those who need it, at the time and place it is needed (Dorasamy et al, 2013). Access to adequate infrastructure is a prerequisite for organizations and individuals to adopt and use ICTs. Improved ICT infrastructure can provide platforms for advanced tools to support CCI management, which can, in turn, result in improvements to risk reduction practices and disaster response coordination efforts.

In Uganda, the Uganda Communications Commission (UCC) started and administers a Universal Service Fund (USF) for communications in accordance with the provisions of the Communications Act of 1997. The USF is called the Rural Communications Development Fund, and its main objectives are to: Provide access to basic communications services within a reasonable distance to all the people in Uganda; Leverage investment into rural communications development; and Promote ICT usage in Uganda.

With these and other strategies in place, Uganda is the third highest user of ICT in East Africa, ahead of Tanzania and Burundi but behind Rwanda and Kenya. Uganda is ranked 110th in 144 surveyed countries by the World Economic Forums Networked Readiness Index 2013 under the theme "Benchmarking ICT uptake and support for growth and jobs in a hyper connected world." The report informs decision makers and investors on ICT readiness and usage in several economies. Uganda government's usage of ICT ranks 88th globally, with business and individual usage showing large room for improvement at 106th and 131st respectively (http://www.newvision.co.ug/).

Statement of the Problem

Information and Communication Technologies (ICTs) can be used to support the management of climate change impacts through preventive action, crisis management and reconstruction. This could be through detection and analysis of climate change, propagation of early warning messages to populations, coordinating and tracking relief activities and resources, recording and disseminating knowledge and experiences, and raising awareness (UN-APCICT, 2010). Uganda has witnessed several climate change impacts in the last two decades, and although Uganda's usage of ICT in business is well documented (ranked 106th globally), there has been scanty literature on the use of ICT in management of the climate change impacts. Therefore, the present study sought to widen the understanding and knowledge on the use of ICT in climate change management in Uganda in order to suggest strategies for improvement.

Purpose of the Study

The study set out to examine the use of ICT in the management of climate change impacts in Uganda with the view to identify the challenges and propose strategies for improving ICT use in management of climate change impacts.

Objectives of the Study

i. Examine the role of ICTs in facilitating the mitigation of climate change impacts in Uganda
ii. Identify the challenges of utilizing ICT in mitigation of climate change impacts in Uganda
iii. Find out how the challenges could be addressed to improve on use of ICT in climate change impacts.

Research Questions for the Study

ISSN 2304-0777 www.jitbm.com

i. What role has ICT played in facilitating the mitigation of climate change impacts in Uganda?
ii. What are the challenges of utilizing ICT in mitigation of climate change impacts in Uganda?
iii. How can the challenges of utilizing ICT in mitigation of climate change impacts in Uganda be addressed to improve on use of ICT?

Scope of the Study

The study was done in the five districts of Bugisu sub-region near Mount Elgon, which are all prone to landslides and mudslides. The period between 2011 and 2016 was considered for the investigation.

Significance of the Study

This study provides a wealth of data that can be used to ensure timely and effective delivery of early warnings to the remotest household in case of a disaster. The results will further be useful in ensuring rapid, reliable two-way communication in challenged environments, since the period immediately after a disaster strikes is considered the most difficult, fluid, and confused. Both one-to-one and one-to-many, preferably two-way communication channels are needed. Widespread mobile phone subscribership and 24-hour connectivity allows large-scale SMS-based evacuation and rescue operations. Survivors who are marooned can use mobile phones to guide rescue teams to their location, to tell district officials of their immediate needs, and to share their plight with local and international media.

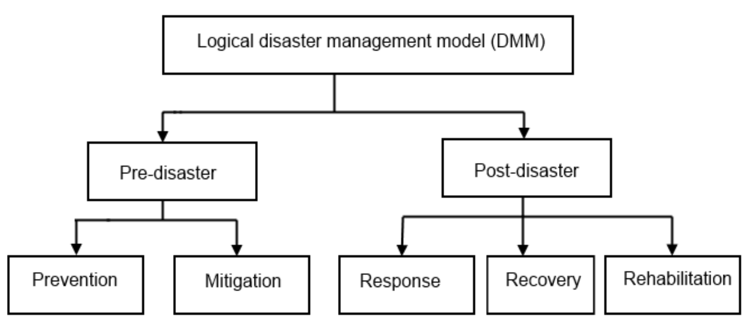
The results have created a common operational picture whereby voice communication is typically viewed as the immediate need prior to and after the onset of a disaster, but as noted above geospatial data are equally critical for assessing damage, planning relief operations and coordinating relief activities.

The results have established transparency and accountability thereby ensuring that major disasters will generally trigger an outpouring of technical and financial assistance from ordinary citizens around the world, usually channeled through donors and NGOs. Accordingly, Platt (2007) recognizes web 2.0 tools as enablers of information sharing, collaboration and creation of user-generated content in areas with broadband Internet connection. People serving as 'sensors', crowd sourcing information from mobile phone, email, RSS feeds, the web, and feeding it to decision-makers, add immense value to search and rescue operations and impose transparency in aid allocation and delivery (Platt, 2007).

Models of Disaster Management

There are several models that explain how management of disasters such as CCIs. The models provide a useful framework to guide the planning efforts of disaster management agencies (NRF, 2008). The traditional models of disaster management branch into two phases, namely pre- and post-disaster. The pre-disaster phase generally comprises of two sub-phases: prevention and mitigation. The post-disaster phase can comprise the sub-phases of response, recovery and rehabilitation www.restoreyoureconomy.org

These are exemplified in Figure 1 below:



International Journal of Information Technology and Business Management
29th January 2017. Vol.56 No.1

ISSN 2304-0777 www.jitbm.com

Fig.1: Logistical Disaster Management Model (Source: Chirilov, et al., (2006))

Another representation of a traditional disaster management model, as shown in Figure 2 below, is the four phase model: mitigation, preparedness, response and recovery. Although it is at the phases of response and recovery that disaster-related issues receive the most attention, mitigation and preparedness are being recognized as key phases that will save lives and contribute to sustainable social and economic development. Recent studies1 have shown that every dollar invested in disaster preparedness not only saves lives, but can also save between US$ 4 and US$ 7 in humanitarian relief and reconstruction costs after a disaster occurs (UNESCAP, 2008).

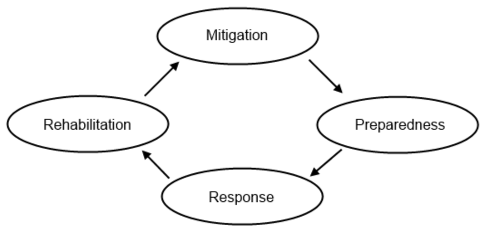


Fig.2: Disaster Management Cycle (Source: Tomasini & Van Wasserhove (2009)

In the diagram above, "mitigation" considers all measures to avoid or reduce the adverse impacts of hazards and related disasters (Williams and Phillips 2014; Pearce, 2000). In some cases, adverse impacts may be wholly prevented (Pearce, 2000), for example through dams or embankments that eliminate flood risks and land-use regulations that do not permit any settlement in high risk zones (Williams and Phillips 2014). Very often, however, the complete avoidance of loss is not feasible and the task transforms to that of mitigating, or lessening the impact of an adverse event (Alcayna, et al, 2016). Partly for this reason, the terms prevention and mitigation are sometimes used interchangeably (UNISDR, 2009). The mitigation function encompasses engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness. Preparedness represents the knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals (Alcayna, et al,2016; UNESCO, 2007), to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions (UNISDR, 2009). It is based on a sound analysis of disaster risks and good linkages with early warning systems.

Response is considered to be the provision of emergency services and public assistance during or immediately after a disaster in order to save lives, minimize health impacts, ensure public safety (Magolo, 2014) and meet the basic subsistence needs of the people affected (UNISDIR, 2009). The rehabilitation phase (Guarnacci, 2012), which also includes recovery and reconstruction (Williams and Phillips 2014), encompasses the restoration and improvement "of facilities, livelihoods (Carr-Hill, R and Ondijo D (2011) and living conditions (Ospina and Heeks, 2011) of disaster-affected (Alcayna, et al, 2016, Magolo, 2014) communities, including efforts to reduce disaster risk factors (UNISDR, 2009). Recovery programmes, coupled with the heightened public awareness and engagement after a disaster, afford a valuable opportunity (Guarnacci, 2012) to develop and implement disaster risk reduction measures (Ospina and Heeks, 2011) and to apply the 'build back better' principle (Williams and Phillips 2014; Clinton, 2006).

Role of ICTs in facilitating the Mitigation of Climate Change Impacts

Cooper et al., (2008) noted that whilst the exact nature and extent of the impacts of climate change on temperature and rainfall distribution patterns remain uncertain, it is the poor and vulnerable (Dines et al, 2011; Jat et al, 2011) who will be the most susceptible to changes in climate. Because of rural people's vulnerability to climate change, there is need to devise strategies and coping mechanisms that

ISSN 2304-0777 www.jitbm.com

enhance rural people's capacity to adapt to and also participate in the mitigation of climate change. In order to strengthen people's capacity to adapt to climate change, it is necessary to implement strategies through the use of ICT in educating people (Ngigi, 2009). ICT has been found to play a critical role within decision-making processes and is the basis to mobilize action within and for rural agricultural communities (Ospina and Heeks, 2011). ICTs are diverse ranging from fixed telephones, radios and TVs to more complex technologies such as internet technologies, mobile telephone, computers and databases (ibid).

Likening the ICT revolution to the first machine-driven industrial revolution, Baskaran and Muchie (2006) noted that ICTs have generated fundamental changes in the socio-economic lives of people and nations across the world (Muchie & Mudombi, 2011). The United Nations has noted that ICT will become one of the main enablers in pursuit of poverty alleviation (UN Millennium Project, 2005; Muchie & Mudombi, 2011), as a facilitator of networking, processing, distribution and sharing of knowledge and information. There are many ICT applications in environmental issues which are categorized as: environmental observation; environmental analysis; environmental planning; environmental management and protection; impact and mitigating effects of ICTs utilization; and environmental capacity building (ITU, 2008). ICTs are potentially useful in capacity building (ATPS, 2013) towards climate change awareness and adaptation (Mwawasi, 2014). Capacity building includes efforts to increase public awareness (ITU, 2008) of environmental issues and priorities, the development of professionals (ATPS, 2013) involved either directly or indirectly in the environment, as well as integrating environmental content (Saravanan, 2011) into formal education (ibid). Of the few studies that have been done that focus on the application of ICTs in different aspects of climate change, the University of Manchester's Climate Change, Innovation and ICTs Project is at the forefront. It provides evidence through the various case studies on the application of ICTs to the different aspects of climate change. One case study examining "Climate Smart Agriculture" among farmers in North-East India highlighted the need to prioritize appropriate ICTs in rural areas, such as the radio and TV for general awareness and mobile phones for individualized assistance (Saravanan, 2011).

Additionally, there are various ways in which ICTs can help in reducing the effects of climate change. However the availability and adoption of ICTs is varied between areas: developed and developing countries; urban and rural areas and within rural areas themselves. Even when the ICTs are available, the information that is transmitted is also varied and its reception is varied. Thioune (2003) noted that ICTs are known to transform communities, however the details of these transformations, the degree and pace of such changes are yet to be fully grasped, hence the need for more empirical data, such as this study provides.

Ospina and Heeks (2010) noted that literature linking both the potential and challenges of ICTs in the climate change field began to emerge at the beginning of the 2000s. There are now an array of ICT applications and infrastructure that are well-suited to the disaster risk management including climate change impacts can broadly be divided into categories of communications technology, tools for collaboration, and systems related to mapping and sensing.

1. Communications Technology

a) Radio: Radio technology has long been a staple of disaster management communications systems. Ultra-high frequency (UHF) radio is commonly used as a medium to support voice communications. UHF radio has the advantages of being able to work over relatively long distances, with little needed in the way of infrastructure. UHF is widely used by disaster management (Williams and Phillips 2014) offices within the Caribbean, and there are specific channels reserved for communication in emergency situations. Crucially for the Ugandan situation, UHF is well suited to communications between highlands and mountains. In addition to professional users, there is a large community of amateur radio operators (Platt, 2007).throughout the world with the training and skills to provide emergency communication facilities during an emergency (APCICT, 2010).

b) Mobile phones: The availability of mobile phones has greatly increased over the past decade, and the technology now represents an opportunity to be in direct, two-way contact with a broader population

ISSN 2304-0777 www.jitbm.com

than ever been before. Mobile phone technology has much potential as an early warning system that to alert a populace of impending danger. It also shows value in a post-disaster situation, when mobile communications can be used to organize response and recovery efforts, in close coordination with those in need of services.

c) Social media: Social networks, such as Twitter and Facebook, represent a newly emergent channel of communications (Williams and Phillips 2014; ATPS, 2013) that has gained great social prominence over a relatively short span of time. A 2011 report on Social Media and Emergency Management offers an in depth look at the potential DRM applications of this new technology, and offers three major reasons that emergency managers should engage with social media: i). meeting and managing citizen expectations; ii). Increasing situational awareness; and iii). Crowd sourcing and leveraging citizens as force multipliers. The report cites a survey conducted in 2010 by the American Red Cross indicating that many internet users already have an expectation that they should be able to use social tools to engage with emergency response organizations. The report concluded that there is significant value to be gained by an organization that establishes a social media presence and actively sets expectations of its response capabilities through active dialogue with its constituents (Wardell and Su, 2011; Robson, 2011).

Disaster management organizations that use social media, however, must consider that following an event, organizations can be bombarded with questions and requests for assistance through these channels. Procedures need to be in place beforehand to determine how such queries should be handled, and expectations need to be communicated (Robson, 2011; National Council for the Disability, 2014) to the social media audience. There should also be a clear system for approving the release of messages that may have a reputational impact on the disaster management organization or on the government. Social media governance policies should include determination of who is responsible for the release of information through social channels and should establish standard procedures for ensuring that these messages are appropriately vetted (William, 2015). In addition, these policies should cover both how social media is used on a day-to-day basis, (Wardell and Su, 2011; Williams and Phillips 2014) as well as how social media tools are to be used in early warning situations, and in communicating information to the public (Williams, 2015).

2. ICT Tools for coordination and collaboration

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

b) Crisis mapping tools: In recent years, there has been an emergence of volunteer-organized online networks (Williams and Phillips 2014) that provide mapping and data collection services to aid in disaster response efforts. The International Network of Crisis Mappers (http://crisismappers.net/) is one such community of volunteers. The volunteers, who have varying levels of training and experience, collect and analyze data using a variety of freely-available tools (Williams, 2015). This information is then relayed to responders on the ground in the disaster-affected area. Ushahidi (http://www.ushahidi.com/) is an example of one tool used by crisis mapping networks. It is an open-source project for use in post-disaster situations that gathers information drawn from public contributions to a number of sources, including SMS, email, Twitter (Thompson, 2010) and other web-based and social media applications. The collected public information is then filtered (Williams, 2015) and displayed through Google Maps for use by emergency responders (Williams, 2015; Robson, 2012; Thompson, 2010) and is used to direct aid to the places where it is needed most. The “crowd sourcing” aspect of this application is valuable because it can generate a much broader set of information in times of emergency than what is available through strained and limited governmental sources. Ushahidi was used after the 2010 Haiti earthquake, where it processed nearly 40,000 individual reports from the public, covering over 4000 unique events (Meler, 2014).

3. Mapping and remote sensing systems

ISSN 2304-0777 www.jitbm.com

Remote sensing refers to the process of recording information from sensors (Hassan, 2015; Omieno & Khabamba 2012) mounted either on satellites or aircrafts. Earth observation satellites, for example, can be used to view the same area (Williams, 2015; Robson, 2012) over long periods of time and thus make it possible to monitor environmental change, human impact and natural processes (APCICT, 2013). This helps scientists and planners create models (Omieno & Khabamba 2012) to simulate trends observed, and offer projection for the future. This data is also used by national meteorological agencies, (Williams, 2015) which are often responsible for initial warnings concerning weather-related disasters (storms, floods, cyclones). In most countries, these agencies also rely heavily on ground-based networks of radars.

a) Satellite imaging: Satellites provide information for wide geographic areas, including oceans, and can improve forecasting (Williams and Phillips 2014) to make warning systems more efficient (Yang, 2013). Increasingly, many countries are practically putting their reliance on satellite data as this allows continuity in the observation of global weather (Thompson, 2010). Accordingly, all OECD countries now have national meteorological agencies (OECD, 2012) and all G20 countries have satellites in orbit (OECD, 2012; Yang, 2013). The challenge remains with small and mainly developing countries who do not have direct access to satellite resources (Adiningsih, 2010) and are dependent on systems provided by other countries and international organizations (Yang, 2013). The United Nations Institute for Training and Research (UNITAR) offers countries access to satellite data through the UNITAR Operational Satellite Applications Programme (Williams and Phillips 2014). According to UNITAR, "UNOSAT is a technology-intensive programme delivering imagery analysis (APCICT, 2013; UNITAR, 2013) and satellite solutions to relief and development organizations (Omieno & Khabamba 2012) within and outside the United Nations system to fast track humanitarian relief, human security alongside strategic territorial and development planning (Meler, 2014). A review of maps created through the UNOSAT mechanism with dismay demonstrates that most countries have not taken advantage satellite imaging in a post-disaster analysis (UNITAR, 2013).

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

4. Geographic information systems (GIS)

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

a) Usage of GIS: GIS can be used in all phases of the disaster management cycle. It can be used to identify high risk areas and prioritize them for mitigation activities. In the preparedness phase, GIS can be used to identify evacuation routes, shelters outside the hazard zone, and resources available (people, equipment, supplies) in the area and its vicinity that can be mobilized in the event of a disaster. For response, GIS is useful in prioritizing areas for search and rescue, and planning the route for delivery of relief supplies and medical assistance. In recovery, GIS can be used to plan reconstruction (APCICT, 2010). GIS systems are already in wide use across the Caribbean. Jamaica, for example, has an office responsible for the implementation of GIS systems throughout the government, which, as part of their mandate, supports Jamaica's Office of Disaster Preparedness and Emergency Management

(ODPEM). ODPEM has integrated GIS into vulnerability mapping and scenario planning, and also has its own emergency GIS unit. In case of any major event, GIS specialists are pulled in from across the government to form an emergency team to do data analysis (ECLAC, 2013).

b) Web mapping systems: In the past, GIS systems, such as Arc-GIS, have been expensive to implement and have required highly specialized skills. However, in recent years an array of new "web mapping" tools have come on the market, notably Google Maps (http://maps.google.com), Bing Maps (http://bing.com/maps), and Open Street Map (http://www.openstreetmap.org). These tools support many of the capabilities of the older generation of GIS systems, but provide a less complex interface that is more easily embeddable in other web-based tools. Many of the difficulties of hosting GIS systems are also removed from the equation, as these systems are hosted on the servers of the organizations that have developed and maintain them. At low usage levels, these systems are available free of charge. These systems represent a broad simplification and democratization of GIS technology, and should be strongly considered in the implementation of new tools for DRM. The Ushahidi platform, discussed above, is one example of a product built around Google Maps' capabilities. Another is DEWETRA, which is a system designed and operated by the Italian government for flood and wild-fire forecasting.

Challenges of utilizing ICT in Mitigation of Climate Change Impacts

It must be recognized that, in spite of the reported ubiquity of mobile phone technology, members of some of the populations most vulnerable to disaster may still be without handsets. These populations include poor people, the elderly, as well as children. Additionally, for a handset to be usable in an emergency situation, it must be charged up and turned on, and the user must be familiar with its messaging capabilities. This challenge demonstrates that, in practice, no one ICT channel or communication burst will reach an entire population. A multi-channel approach inclusive of more traditional systems, such as siren systems and radio, will be required as means of maximizing the possibility of reaching endangered populations. Members of the public are also likely to be more responsive to early warning alarms if messages are transmitted simultaneously and continuously through different mediums and channels. Source: Report on the expert group meeting on information and communication technologies for disaster risk management in the Caribbean (ECLAC, 2013).

Dealing with the challenges to improve on use of ICT in Climate Change Impacts

There seems to be a gap in terms of knowledge-sharing between disaster management agencies and other communities, including the ICT community and policy makers. Frequently, disaster management practitioners are not even part of ICT planning discussions. This may contribute to the funding constraints which many respondents cited as impediments to doing more in disaster management with ICTs. It would be useful for the disaster management community to make a more concerted effort to reach out beyond their sector and build greater bridges to other professional communities. They should endeavour to connect their work with other areas of national and regional economic importance, such as tourism, agriculture, poverty eradication and sustainable development amongst others. A strong case can be made that the economic impact of disasters has a direct bearing on the sustainability of other sectors important for the economic prosperity of developing countries, leading to a shared sense of urgency.

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

There is also a need to increase the amount of ICT infrastructure available to support hydrology and meteorology information gathering, hazard and vulnerability assessments, early warning alerting, quick response capability, and the coordination of rehabilitation activities both nationally and with international partners. Mobile devices (tablets and smart phones) for field workers, integrated GIS mapping tools for in-house professionals, disaster management databases and crisis management software should be among the standard tools available in every national DRM agency. The feedback from the survey suggests that while some DRM offices are equipped with these tools, many others do not have their full complement. The lack of access to modern and up-to-date ICT infrastructure can severely hamper the effectiveness, timeliness and capability of a disaster management authority to competently respond to the occurrence of a national hazard.

Nevertheless, ICT systems should not be imposed on a national disaster management agency without adequate assessment needs and organizational readiness. While a consideration of potential technological solutions may prove useful, an assessment should also consider the disposition of the key actors toward ICTs, the state of human and institutional capacity, the availability of relevant and accessible data, the quality of current infrastructure and the maturity of governance arrangements. These considerations must be evaluated before equipment is bought. In this regard, this study recommends that each disaster management agency in the region undertake to implement their own e-readiness assessment, at the organizational level, that can form the basis for the development of their strategy for ICT infrastructure upgrading.

Methodology

A multi-stage sampling approach was used. The sampling unit was a household and a sample size of 150 households was used in the study, with 30 households coming from each of the five districts in the Bugisu sub-region. One respondent, supposedly the household head was selected from each household; however if the household head was not available, any other adult member of the household could respond. Data collection was conducted from February to March 2016. The information was cleaned and entered for analysis using SPSS and Excel. The study focused on three main issues: the role of ICT, the challenges to ICT, and suggested strategies for improvement. Therefore, focus was on radio; television; video cassette recorder (VCR); digital video disc (DVD) player; fixed telephone; mobile phone; satellite decoder; computer; internet; and the traditional print media (newspapers; farming/environmental magazines; business magazines; entertainment magazines; church magazines; and posters).

Results and Discussion

Household characteristics

From the sampled households, 32.1% were female-headed while 67.9% were male-headed households. The minimum and maximum ages of household heads were 23 and 98 years respectively with a mean age of 52.23 years. The minimum and maximum household sizes were 1 and 18 respectively with a mean of 5.84 members. The majority of the household heads had basic education, and only 4.3% of the household heads did not have any basic form of formal education.

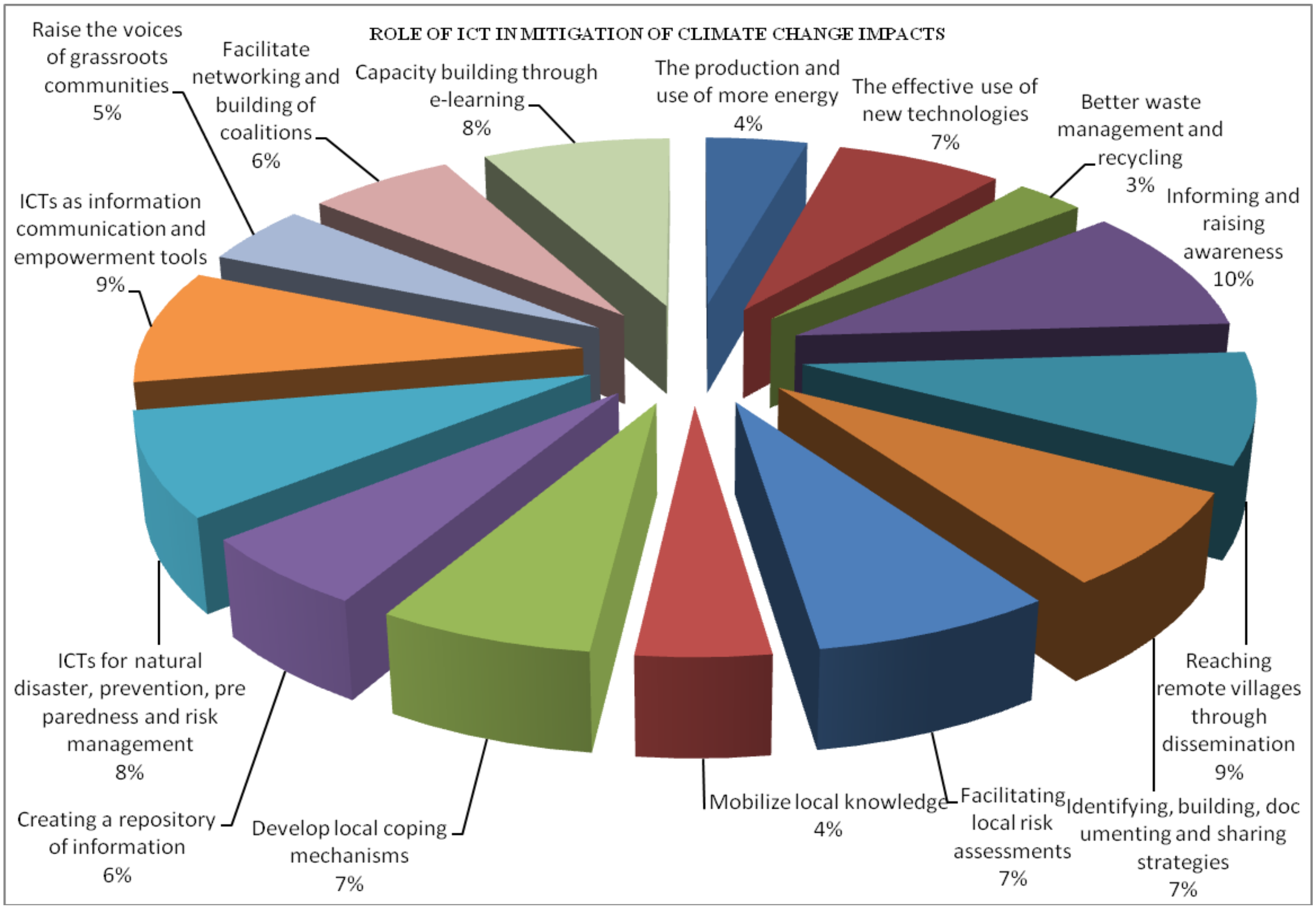
Knowledge of and Access to Information and Communication Technologies

Both old and new ICTs were analyzed. Greenberg (2005) noted that the categorization of ICTs (new, old, and really old) generally apply to the developed world; in many parts of the developing world, and particularly in areas where literacy rates are low, they are *all* relatively new. This implies that those ICTs that are generally classified as old might be new or even unknown in some rural areas. Therefore in exploring access to ICTs, the initial step was to evaluate whether the respondent knew the various ICTs, which was then followed by assessing ownership of the ICTs by different members of the household. Ownership of ICTs by any household member was taken as a proxy of access to ICTs by the respondent. A shortcoming of the approach was the failure to incorporate access to ICT through people who were not part of the household. The results on ICT knowledge and access are presented in Table
1.

Table I

International Journal of Information Technology and Business Management
29th January 2017. Vol.56 No.1

ISSN 2304-0777 www.jitbm.com



Source: Primary data

From Figure 1, it can be noted that there are various roles that ICT plays in mitigation of climate change impacts. These can be categorized as;

a). ICTs for mitigation - Mitigate the vulnerability

There are three main areas of mitigation that are relevant to ICTs:

i) The production and use of more energy- and carbon-dioxide-efficient ICTs, including the transfer of this technology to developing countries. This will contribute to the de-carbonization of the economy. There is a role here for development cooperation between countries and regions.

ii) The effective use of new technologies such as video conferencing and voice over internet protocol (VoIP) which have the potential to reduce the emissions from travel.

iii) Better waste management and recycling.

b). ICTs for adaptation - from exclusion to inclusion

i. Informing and raising awareness on the effects of climate change.

ii. Reaching remote villages through dissemination, hence enhancing the effectiveness of early-warning systems for disaster prevention and risk reduction.

iii. Identifying, building, documenting and sharing locally rooted and contextualized adaptation strategies and solutions among communities.

ISSN 2304-0777 www.jitbm.com

iv. Facilitating local risk assessments and making communities part of the process to mobilize local knowledge and develop local coping mechanisms.
v. Creating a repository of information on disaster management and risk mitigation.

c). ICTs for natural disaster, prevention, preparedness and risk management: ICTs offer tools relevant for data analysis, satellite imaging and vulnerability assessment, coordination of emergency efforts, and dissemination of locally specific and relevant information (e.g., early-warning systems, meteorological information for preparedness disseminated through telecentres or mobile phones).

d). ICTs as information communication and empowerment tools (including community radio, knowledge centres, mobile phones, internet, and internet-based media) can be used for both mitigation and adaptation efforts in order to:

i. Inform and raise awareness (e.g., media campaigns) at all levels of society – including the poor – about the effects of climate change.
ii. Raise the voices of grassroots communities and those most affected by climate change – again, mostly the poor in developing countries – at the local, national and international level, and carry them to the decision makers to demand actions from their leaders and political accountability (advocacy function/vertical linkages).
iii. Facilitate networking and building of coalitions and help define positions (including for mitigation and adaptation strategies).
iv. Capacity building through e-learning as vertical learning and knowledge sharing as horizontal, peer-to-peer learning.

Challenges of Utilizing ICT in Mitigation of Climate Change Impacts

A number of challenges were identified by the respondents. These included:

- Lack of financial resources amidst other competing priorities of basic nature. The gadgets used for communicating are not affordable for example computers and phones used for internet. The few respondents who had computers expressed inability to get connected to internet due to high connection costs and maintenance of the connectedness to the service. Those with phones need airtime to make a voice call or send a message. All these expenses combined make the whole idea of ICT in the management of CCI rhetoric in developing countries.
- Respondents pointed out limited access to internet in most of the areas where the study was conducted, besides poor electricity access and supply.
- Community leaders whom the researcher interacted with pointed out that they do not see the need to purchase and subsequent installations of computers, say in their schools or computer centers within communities as a priority. They consider health care, provision of water and other amenities as more important.
- Others pointed out that ICT has increased moral degradation – internet pornography, and other anti-social behaviors which were seen as a very serious problem to the youths.

Out of the above challenges, it was found out that the cost of software and hardware were the most outstanding challenges while lack of perceived benefits was considered the least of the challenges encountered in utilizing ICT in mitigation of climate change impacts in Uganda.

How to Address the Challenges to Improve on Use of ICT in Climate Change Impacts

From the analyzed data, it was found out that respondents suggested that in order to deal with the challenges of utilizing ICT in mitigation of climate change impacts would be by dealing with the challenges hitherto identified. That is, making accessibility of both the soft and hard ware affordable, training more personnel so as avoid paying expensively for the few qualified persons,

ISSN 2304-0777 www.jitbm.com

create awareness among different stakeholders; provide security for internet users, reduction of taxes on ICT services and also reduction of the ICT connection fees.

Conclusions

The results do reveal that while the developed countries may have significantly adopted the use of ICT in mitigation of disasters such as climate change impacts; developing countries like Uganda are still lagging behind in usage of ICT especially in mitigation of climate change impacts. It can be concluded that there are several roles that ICT can play in climate change impacts but there are also a myriad of challenges that have to be dealt with. The low usage is due to the high cost of required investment, limited knowledge and skills, and being very responsive to taxation. The findings suggest that there is need to widen ICT training facilities for the local community members to take advantage of opportunities associated with the adoption of ICTs; and to address taxation on the Internet services and other ICT consumables to lower the cost of acquisition.

Recommendations

It can be recommended that the government should develop policies that are geared towards addressing the challenges hitherto identified and promotion of ICT adoption and usage.

References

1. Adiningsih, E.S (2010) the application of Satellite Remote sensing on Climate Change and Food Security in Indonesia, Aerospace Analysis and Information Center53rd Session of UN-COPUOS, Vienna / June 9-18, 2010
2. African Technology Policy Studies Network, ATPS 2013: Role of information Communication Technologies (ICTs) in climate Change Awareness in Seke and Murewa Districts of Zimbabwe [Shakespear Mudombi], ATPS WORKING PAPER No. 75
3. APCICT (2013) Primer Series on ICTD for Youth: An Introduction to ICT, Climate Change and Green Growth, Asian and Pacific Training Centre for Information and communication Technology for Development
4. Baldwin, J.R. and B. Diverty (1995), Advanced Technology use in Canadian Manufacturing Establishments, Working Paper No. 85, Microeconomics Analysis Division, Statistics,Canada, Ottawa.
5. Bartelsman, E.J., van Leeuwen G. and Nieuwenhuijsen H.R. (1996), Advanced Manufacturing Technology and Firm Performance in the Netherlands, *Netherlands Official Statistics*, Vol.11 Autumn, pp 40-51
6. Brynjolfsson E., Hitt L.M., 2000, Beyond Computation: Information Technology, Organisational Transformation and Business Performance, *Journal of Economic Perspectives* – Vol. 14, 4,pp 23-48.
7. Communication Technologies (ICT) (2004) adoption and Usage www.statistics.gov.uk.. Accessed March 2016
8. Carr-Hill, R and Ondijo D (2011) Assessment of the Education, Livelihoods, Living Conditions and Welfare of Somali Pastoralists, A Representative, Multi-Sectoral Survey Conducted to Provide a Baseline for Programming
9. Dunne T. (1994), Plant and Technology usage in US manufacturing industries, *RAND Journal of Economics*, volume 25, pp 488-499.
10. Dimes, J.P. Cooper, J. and Rao, K.P.C. (2011) Climate Change Impact on Crop Productivity in the Semi-Arid Tropics of Zimbabwe In The 21st Century
11. Gretton P., Gali J. and Parham D. (2002), Uptake and Impacts of ICTs in the Australian Economy: Evidence from aggregate, sectoral and firm levels, *Productivity Commission, Canberra, Australia*

ISSN 2304-0777 www.jitbm.com

12. Guarnacci, U, (2012) Governance for sustainable reconstruction after disasters: Lessons from Nias, Indonesia, Environmental Development Volume 2, April 2012, Pages 73–85
13. Hassan A. A. M.D (2015) Role Of ICT in Natural Disaster Management of Bangladesh, A Dissertation for the Degree of Master in Disaster Management
14. ITU (2004), ITU World Telecommunication Indicators Database, http://www.itu.int/ITUD/ict/statistics/index.html. Accessed on 28/4/2016
15. Jat, A. R., Craufurd, P., Wani, S.P. (2011) Resilient Dry land Systems for Reducing Vulnerability to drought and Climate Change while increasing crop diversity and value: The ICRISAT Experience, International Crops Research Institute for the Semi-Arid Tropics, Pradesh, India
16. Knight J. and Pollard M (2004), 2003 E-commerce Survey of business: Information and OECD, (2003), ICT and Economic growth, Evidence from OECD countries, industries and firms, *OECD*
17. NRF (2008) The National Response Framework, available at www.restoreyoureconomy.org
18. Ngplains (2002), Information Technology Tends, www.ngplains.org/documenst %5cInformation Technology Trends, pdf.. Accessed on 8/3/2016
19. Uganda Communication Commission (2005), http://www.ucc.co.ug, Accessed on 20/4/2016
20. Williams R.C. and Phillips, A. (2014). Information and communication technologies for disaster risk management in the Caribbean, Studies and perspectives, ACLAC, UN.
21. Meler P. (2010) Crisis Mapping Haiti: Some final reflections: www.ushahidi.com
22. Muchie, M., & Mudombi, S. (2011). Analysis of the Role of Information and Communication Technologies (ICTs) in Climate Change Awareness in Seke and Murewa Districts of Zimbabwe. Paper presented at First conference on climate change and development in Africa, Addis Ababa, Ethiopia.
23. Mwawasi F.M (2014) Technology Leadership and ICT Use: Strategies for Capacity Building for ICT integration, Journal of learning for Development, Vol. 1 No2.
24. Omieno K. K. & Khabamba I (2012) International Conference on Disaster Risk Reduction and Conflict Resolution for Sustainable Development: ICT In Disaster Risk Reduction: Kenyan Experience
25. Robson, E.S. (2012) responding to liability: Evaluating and reducing Tort Liability for Digital Volunteers.
26. Williams R.C. (2015) Information and communication technology for disaster risk Management in the Caribbean: sub-regional solutions to the challenge of limited human resource capacity, ECLAC.
27. Yang, J. Gong, P., Fu, R., Zhang, M, Chen, J. Liang, s., Xu, B., Shi and Dickinson, R (2013) The role of satellite remote sensing in climate change studies, Nature, Climate Change, DOI: 10.1038/NCLIMATE1908