Role of Open Source Software and ICT in Disaster Management

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Abstract— A disaster is a situation in which the community is incapable of coping. It is a natural or human-caused event which causes intense negative impacts on people, goods, services and/or the environment, exceeding the affected community's capability to respond; therefore the community seeks the assistance of government and international agencies. In this chaotic environment, new alliances, groupings, collaboration, and trust need to be quickly formed between government organizations, civil society, foreign aid groups, and volunteers to effectively muster their energies into a holistic response effort. Information technology can play a valuable coordination role for situation awareness and enable responders to act effectively. In particular, open source software has been found to be a good fit for the dynamic "bazaar"- like environment of a disaster and a good match to the humanitarian codes of conduct. "Free and open source software is increasingly being used in many spheres of development including disaster management. The paper illustrates Disaster management and empowerment of communities in developing nations through appropriate open source applications and also describes the functioning of the "Sahana" disaster management system deployed during the 2004, Indian Ocean Tsunami. Sahana used free and open source software to create number of functionalities.

Index Terms— Disaster management, Open Source Software, Information Technology, Sahana.

1 INTRODUCTION

A hazard can become an emergency; when the emergency moves beyond the control of the population, it becomes a disaster. An emergency and a disaster are two different situations:

An ***emergency*** is a situation in which the community is capable of coping. It is a situation generated by the real or imminent occurrence of an event that requires immediate attention and that requires immediate attention of emergency resources.

A ***disaster*** is a situation in which the community is incapable of coping. It is a natural or human-caused event which causes intense negative impacts on people, goods, services and/or the environment, exceeding the affected community's capability to respond; therefore the community seeks the assistance of government and international agencies. Disasters, by definition, are devastating events that overwhelm the affected society's capacity to respond and mitigate.

Types of natural and non-natural disasters

Disasters are often classified according to their:

- causes – natural vs. human
- speed of onset – sudden vs. slow

Causes

Natural Disasters

These types of disaster naturally occur in proximity to, and pose a threat to, people, structures or economic assets. They are caused by biological, geological, seismic, hydrologic, or meteorological conditions or processes in the natural environment (e.g., cyclones, earthquakes, tsunami, floods, landslides, and volcanic eruptions).

Cyclones, Hurricanes or Typhoons

Cyclones develop when a warm ocean gives rise to hot air, which in turn creates convectional air currents. Cyclones occur when these conventional air currents are being displaced. The term hurricane/typhoon is a regionally specific name for a "tropical cyclone". In Asia they are called 'typhoons'; in the Indian and Pacific Oceans they are called 'cyclones'; and over the North Atlantic and Caribbean Basin, they are called 'hurricanes'.

Earthquakes

An earthquake is a trembling or shaking movement of the earth's surface, resulting from plate movements along a fault-plane or as a result of volcanic activity. Earthquakes can strike suddenly, violently, and without warning at any time of the day or night. The following terminologies are associated with earthquakes: *epicentre, fault, magnitude* and *seismic waves*.

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Tsunami

A tsunami is an ocean wave generated by a submarine earthquake, volcano or landslide. It is also known as a seismic sea wave, and incorrectly as a tidal wave. Storm surges (or *Galu Lolo*) are waves caused by strong winds[1].

Floods

This phenomenon occurs when water covers previously dry areas, i.e., when large amounts of water flow from a source such as a river or a broken pipe onto a previously dry area, or when water overflows banks or barriers. Floods can be environmentally important to local ecosystems. Floods can also have an economic and emotional impact on people, particularly if their property is directly affected. Having a better understanding of what causes flooding can help people to be better prepared and to perhaps minimize or prevent flood damage.

Landslides

The term landslide refers to the downward movement of masses of rock and soil. Landslides are caused by one or a combination of the following factors: change in slope gradient, increasing the load the land must bear, shocks and vibrations, change in water content, ground water movement, frost action, weathering of shocks, removal or, or changing the type of vegetation covering slopes.

Human-Made Disasters

These are disasters or emergency situations of which the principal, direct causes are identifiable human actions, deliberate or otherwise. Apart from "technological disasters" this mainly involves situations in which civilian populations suffer casualties, losses of property, basic services and means of livelihood as a result of war, civil strife or other conflicts, or policy implementation. In many cases, people are forced to leave their homes, giving rise to congregations of refugees or externally and/or internally displaced persons as a result of civil strife, an airplane crash, a major fire, oil spill, epidemic, terrorism, etc. For Disaster Management Open source Software plays an vital role.

2 Open Source Software

The idea of "free software" emerged at a time when large software makers were trying to control the use of software and impose conditions. This was unacceptable for those who freely used software, modified and redistributed. It is in this social environment; Richard Stallman introduced his concept of free software that was based on four primary tenets. These four "freedoms" were:

- The freedom to use the software
- The freedom to study the software
- The freedom to copy and share the software
- The freedom to modify and redistribute the software.

The four freedoms form the basis of the GNU9 general public license (GPL), for the foundation of the free and open source software movement. FOSS, is an umbrella term, it covers many licenses used by free software and opens source software. The two sections are different though there are many

areas of overlap. The licensing system is different for the two initiatives. The Free Software Foundation (FSF) for the free software license and Open Sources Initiative (OSI) for the open sources software license.

Concept of free and open source software

The fundamental principle of FOSS is the freedom associated with developing software. The ability to use, study, freely copy and redistribute any software is the core of the FOSS concept. Freedom to access the sources code is fundamental to development of free and open source software. The FOSS developers are mostly volunteers who are willing to sacrifice their time for a noble cause. In most cases there is no payment attached to FOSS development. However, there are few instances when developers have been paid. The possibility of being able to improve on software freely and redistribute it among the development community contributes significantly towards capacity building among local population. Conceptually, free and open source software is a *renewable* resource.

Sahana is a Free and Open Source Software application which can provide a comprehensive solution for disaster information management, relief and recovery operations. Sahana was developed by a non-profit NGO within a very short period of time to suit the requirements of the Tsunami recovery programme in Sri Lanka. It was subsequently supported by the Swedish International Development Corporation Agency (SIDA) to upgrade the system for global applications in large scale disasters. The system was widely used and deployed in the 2005 Pakistan earthquake and 2006, mudslide disaster in the Philippines. Success of Sahana as a disaster management system can be attributed to the bond between the FOSS philosophy and the humanitarian requirement of disasters. Hence, it was called the "Humanitarian FOSS". This paper discusses the development and application of open source software and review case studies to understand the successes and challenges faced by free and open source software development and applications in the Asian and Pacific region.

The fundamental principle of FOSS is the freedom associated with developing software and SAHANA Disaster Management System is one of the Best software especially designed for disaster management.

3 SAHANA DISASTER MANAGEMENT SYSTEM IN SRI LANKA AND OTHER COUNTRIES

The severity of global disaster occurrences and the propensity of disaster to affect developing countries disproportionately, points to an urgent need for the establishment of an institutional framework and a robust Information Communication System. In this context, short comings of ICT solutions were evident in Tsunami (2004), SARS (2003) and Pakistan earthquake (2005) for effective disaster rescue and recovery. Sahana is a web-based free and open source software especially designed for disaster management. It has the potential to address problems in coordination of relief supplies, manage camps, inventories supplies, find missing people and manage volunteers, to name a few of its functions.

Background

Sahana emerged in Sri Lanka as result of the 2004 Indian Ocean Tsunami. In the immediate aftermath of the Tsunami, there was an outpour of international and local relief for nearly 1 million people who were displaced and assets valued at US$ 900 million were destroyed. Women were affected disproportionately in the Tsunami. Some reports estimated four times more deaths among women than men and in certain parts of the Eastern cost of Sri Lanka, 80 per cent of the dead were women. It was soon realized that without IT based solution it was difficult to coordinate the massive amount of information and also manage the influx of relief. The existing IT systems in Sri Lanka were not time tested for a disaster of this magnitude and none were web-based solutions. To fill in the void, Sahana, a free and open source software based disaster management system was established. In the Sri Lankan national Language (Sinhala) *Sahana means assistance at the time of distress.* The system was versatile to address the common issues that surface during disasters. It could help victims to find missing people, manage humanitarian aid and effectively support coordination among various organizations and institutions in relief and reconstruction. Sahana was initiated by a non profit making NGO involved in research and development in free and open source software development. The phase II of Sahana was funded by Swedish International Development Cooperation Agency (SIDA) to mainstream Sahana in global applications. Keeping in line with the philosophy of free and open source software foundation, Sahana is available for free download and users could modify, improve and redistribute. It is estimated that the latest release of the Sahana system has been downloaded approximately 8000 times since 2006. Sahana system is also available on compact disc which may be used without installing in the hard drive. It can also run on stand alone single laptop for an individual user.

Concept of Sahana Disaster Management System

Sahana is based on the ideals of humanitarian free and open source software. It is primarily intended to bring relief more effectively and efficiently to Tsunami affected victims. Sahana hopes to alleviate human suffering and save lives through effective IT solutions, empower victims and their families to help themselves, protect data on victims to prevent data abuse and coordinate efforts of diverse actors in disaster response.

Role of Sahana in disaster management

As a free and open source software solution, Sahana was able to provide an effective IT based solution in the post Tsunami relief and recovery phase. Nevertheless, its long term objectives include addressing disaster prevention, preparedness, relief and recovery.

It hopes to address the prevention and recovery through the following steps:

- Through an interface to generate CAP (Common Alerting Protocol) messages
- The messaging module to send alert through SMS or e mail to group of people
- Pre-populating the organizational module in anticipation of disaster
- Registering respondents and volunteers and tracking them in advance
- Pre-plotting and setting up evacuation points

Incidentally, in the process of development, Sahana has been customized for disaster preparedness in New York City, where it is customized and pre-populated with data to manage any evacuation process. Sahana disaster management system is versatile. It can be installed in 5 minutes. The portable version of Sahana does not need to be installed as it comes pre-set-up and requires only to copy and click for execution. However, customization may take few days to few weeks based on changes needed and deployment model as deemed for the specific development. Sahana can be deployed in multiple ways from running off a USB to a server farm.

Sahana application description

Sahana is a suite of web-based applications that provide solutions to different problems with regards to information and managing coordination issues during postdisasters. Besides being a database for information, the value it provides is in the well structured and usable interface and the data design, making management of information simple.
In Sahana phase II, 8 modules were released which addresses the key problems identified in disaster recovery and relief42. These modules are: missing person's registry, organizational registry, request/pledge management system, camp registry, inventory management, catalog, messaging and volunteer coordination. Following are the four core modules deployed by Sahana during post Tsunami operations43. These are followed by the optional modules

Missing person's registry
Problem 1 - helping families and next of kin to find each other
Solution 1 - Sahana missing person's directory
Organizational registry

Problem 2 - Coordination all aid groups and helping them to operate effectively as one
Solution 2 - Sahana organizational registry
Problem 3 - capturing the location of all camps and shelters
Solution 3 - The Sahana camp Registry
Problem 4 - Effective utilizing the pledged aid
Solution 4 - Sahana request management system

Sahana deployment strategy

The Sahana system can be deployed on a variety of models. From working totally within a single notebook computer (with or without portable wireless connection) to a fully distributed network platform.

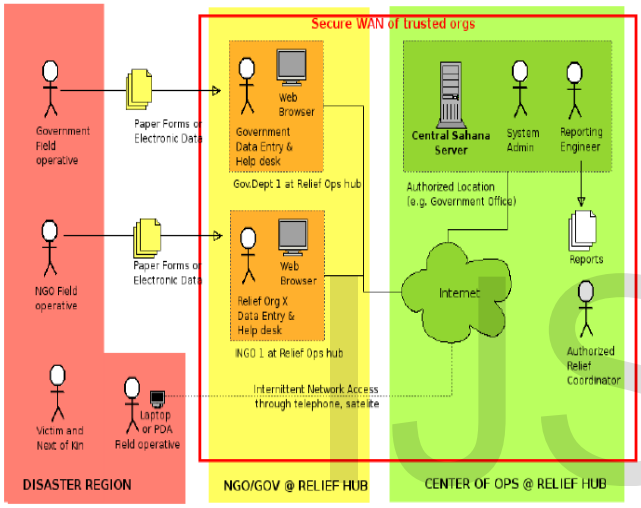

Figure 1. A Possible Sahana Deployment

Large scale deployment

The following diagram illustrates large scale deployment involving multiple stakeholder groups. It is often the case that disaster coordination hub is away from the site of disaster. With deployment of Sahana, the network based operation is often possible even though the affected site (region) might have their telecommunication infrastructure destroyed.
In such an event access can be provided to the affected region with the support from mobile service providers who provide wireless LAN based satellite based connectivity to networks.

Lightweight deployment

If large scale infrastructure does not exist, Sahana being a "lightweight" solution can efficiently scale down to a standalone laptop and a secure portable wireless access point, if short-range network collaboration is required. Such is the case in many disaster coordination hubs when power and Internet are disrupted after disasters. In the absence of power supply, Shana is tested to work with a standalone laptop at 130 watts which can be easily supplied through a solar panel. Besides, none of the applications depend on being connected to the Internet. Sahana has the ability to synchronize data between multiple instances. It allows the respondents or district officers to capture data from victims and exchange with other field offices, headquarters or sharing data in UBS flash drives or CDs.

Access to information to the Sahana database

Access to information and data depends on the deployment model. Sahana has application and data base security. Additionally a firewall and isolation of modules by access is recommended, i.e., some models can be hosted on internal servers versus those shared with trusted entities. Generally it is always advisable to conduct a security audit on the deployment of the system.

Compatibility with hardware and large scale data sensitivity

Sahana runs on Windows as well as Linux tested on X86 based hardware architecture. Handling data is more to do with the databases with regards to Sahana, multiple Sahana web servers (server farms) connect to the databases. Sahana uses open source MySQL database by default. However, Sahana can be easily customized to connect to Oracle or most of the popular databases. Data sensitivity is handled in the Sahana system by application level security (role based access to modules) and an access control based on data sensitivity.

Impact of Sahana system

Introduction of the Sahana system made relief efforts more efficient. It improved rapid information sharing and coordination to avoid redundancy, wastage and to provide aid to the right place at the right time. Besides, it provided situational awareness on tracing people and aid distribution which acted as a decision support for policy makers. This resulted in less over laps and more efficient distribution of relief among the victims. Due to the success of Sahana system in alleviating human suffering during Tsunami, it was adopted by Pakistan, Philippines and Indonesia to manage their respective disasters. Besides, Lebanon and Ecuador too supposed to have adopted Sahana, though it can notbe confirmed . The largest local NGO in Sri Lanka, the Sarvodaya movement, customized and pre-deployed Sahana in preparation for future disasters. The new module on child protection by Terre des Hommes too was based on Sahana system. Sahana has been identified as a "humanitarian FOSS" by the international disaster community due to its humanitarian nature of work. The Free Software Foundation (FSF) of Richard Stallman (creator of FSF) has recognized Sahana as a free and open source software to "help alleviate human suffering" and was duly recognized as a social asset.

Advantages of Sahana for Asia and the Pacific

In the context of Information Communication Technology adaptations, there are number of reasons why Sahana software finds it a natural fit in the humanitarian domain. Sahana can be of immense help to Asian and Pacific member countries,

where 42 per cent of the world disasters have occurred during the past three decades.

• There are very few countries in the region who would invest in disaster management when there are no imminent disasters. Other high priority concerns would take precedence for scares resource allocations. In this context, Sahana, provides the best option as it is already being developed and customized for disaster management. It offers low cost, volunteer supplemented, global system for disaster management.

• There is little commercial interest in developing open source solutions during humanitarian disasters when proprietary software is freely available. But Sahana could be downloaded free and use without any licensing fees.

• Sahana is a *global public good* it is available for anyone who desires to help in any humanitarian cause.

• The global IT community may readily volunteer to improve (or customize) the system if the need arise.

• Sahana offers a global transparent system where inputs and outputs of disaster relief will be transparent to all stakeholders.

Institutional arrangement for Sahana Disaster Management System

As mentioned earlier in the paper, Sahana disaster management system was conceptualized by a group of professionals who were keen on developing a humanitarian FOSS to help Tsumani victims. As such it was created within the NGO domain in Sri Lanka. Although open source is not mentioned in the ICT policy of Sri Lanka, success of Sahana could induce a policy review to include the Sahana disaster management system as a policy option at times of natural disasters. The Information Communication Technology Agency (ICTA) of Sri Lanka, recognizes the work of Lanka Software Foundation (LSF) and offers support when required. The ICTA also offer financial grants in terms of seed funding to NGOs and private companies working on software development. Currently there is an attempt to divest the Sahana disaster management system out of the Lanka Software Foundation and form a new foundation called "Sahana Foundation" where it will be projected as a "global public good" with funding from external sources. The new foundation is expected to be registered in the United States, though 80-90 per cent of technical support to the new foundation will come from Sri Lanka. The copy rights of Sahana will be protected to Lanka Software Foundation. Thus, Sahana will be a global public good with the custodianship firmly vested with the Sri Lankan open source community.

4 Different ICTs for Disaster Management

Timely and Effective Delivery of Early Warnings to the 'Last Mile'

'Last mile' is the term used "to express the sentiment that warnings and the means to respond to them often do not reach those who need it the most", people who for reasons of age, gender, culture or poverty, are not reached by disaster preparedness. It is viewed as the weakest link in the communication chain and seen as the cause of many casualties. People-centred approaches to early warning systems (EWS) are predicated on the assumption that people can be capable, resilient and able to protect themselves given accurate, timely, consistent and actionable information from a trusted source. Such approaches require that individuals and communities at risk, particularly those at the 'last mile', understand the threats to their lives and property, share this awareness with others, and are able to take action to avoid or reduce their exposure. The use of different technologies, preferably one-to-many, is viewed as the effective strategy to deliver early warnings. Any one or a combination of the following media has been used.

Reliable Two-way Communication in Challenged Environments

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. For front-line responders the biggest need is mostly for maps that can be updated in the course of the disaster event, to locate the most affected areas, high-risk areas, and relief distribution centres. For affected communities it is to communicate with the front-line responders, look for family and friends, and increasingly also connect with diaspora communities.The biggest communication surge is said to be in the first 12 hours after the onset with the intensity of demand declining somewhat but remaining high for up to three days. Frequently however, large parts of the telecommunications infrastructure are destroyed or incapacitated for several days if not weeks; those that survive suffer overload. The complex interdependencies of technology systems (e.g., dependency of financial services, transportation, on ICT networks) make them vulnerable to failure from ignorance, human malice and technical malfunction. It also means the failure of one system can lead to failure of another. Communication and coordination under such uncertain conditions has benefited from technological development and the creativity of committed ICT professionals.

Mobile Phones

The usefulness and the limitations of mobile phones in crisis situations were demonstrated during the 2008 floods in Bihar India. Widespread mobile phone subscribership and 24-hour connectivity allowed large-scale SMS-based evacuation and rescue operations. Survivors

who were marooned used mobile phones to guide rescue teams to where they were, to tell district officials of their immediate needs, and local television and newspapers, their plight. The prolonged non-availability of electricity however meant that the mobile phones could not be recharged.

Wireless Ad-hoc Mesh Networks with GPS

When infrastructure is compromised or damaged the common response currently is to deploy satellite communication equipment, cellular and wireless infrastructure and microwave links since they are immediately usable and scalable. Wireless technologies are particularly attractive because they function in difficult terrains and their deployment is relatively inexpensive. After Myanmar was hit by Cyclone Nargis in 2008, a local NGO, EGRESS, developed the *Dumbo-Sahana* Project in partnership with the Myanmar Computer Professionals Association to enhance the communication and coordination aspects of Myanmar's emergency response system. The Project provides training on setting up of *Dumbo* (Digital Ubiquitous Mobile Broadband), wireless ad-hoc mesh networks, GPS mapping, *Sahana* and *OpenStreetMap*. *Dumbo* is a set of network technologies that allows users to chat, transmit video and update their location. The wireless mesh networks penetrate remote, isolated areas with sensors to monitor environmental conditions, e.g., temperature, wind direction and speed. It is rapidly deployable, relatively inexpensive, reliable, resilient and effective in harsh environments.

Internet and e-Mail

The Internet is acknowledged to be one of the most reliable information infrastructures even under adverse physical conditions, and electronic mail, its most widely used application. This was a critical tool during the 1997 Cambodia floods. The floodwaters had washed up venomous snakes and people were being bitten. The local WHO field offices did not have the antiserum in stock nor the taxonomic information on Cambodian snakes. The field officers sent e-mails to members of the Global Health Disaster Network (GHDNet) who forwarded it to several mailing lists. Specialists and institutions in the region were identified resulting in a speedy sourcing of the antiserum. The utility of the Internet and email in disaster management is however limited by the low Internet penetration (2 to 5%) in developing countries and the fact that many of those with connection are not regular users. The non-English content of the Internet also remains limited.

Radio

For the small island of Granada a simpler technology proved to be the most cost- effective tool in 2004 when Hurricane Ivan hit. Approximately 90 percent of the country's homes and nearly every major building in the capital city, including the emergency operations centre, suffered structural damage. Power lines and all communication links were down. A private company, Mobile & Marine Systems received a call for help from the Grenada Police Force. Within 24 hours, Mobile & Marine Systems had in place, portable repeaters, mobile radio base stations and portable handheld radios, which provided the emergency backbone for island-wide communications.

Creating a Common Operational Picture

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 different agencies involved are likely to operate different sets of technical equipment with different data units and standards. Coordination will thus require the extraction, processing and integration of information from multiple sources to create a common operational picture, the lack of which is considered a major barrier to intra- and inter-agency coordination.

Geographic Information Systems (GIS)

Geographic information systems are perhaps the most versatile of all ICT tools and useful in all disaster phases.The power and strength of GIS lie in their ability to integrate spatial with non-geographic data into one encompassing system, and graphically display spatial patterns, creating a common operational picture. GIS allow real time monitoring for emergency early warning as well as modelling of possibilities, e.g., "if we add a road to this community will it significantly reduce evacuation times?". During a disaster event GIS allow one to answer questions of location, e.g., "how many primary schools are within 1 km from this flood flash point?". For recovery and reconstruction the use of historical data with GIS allows one to answer trend questions, e.g., "how has population density changed in the last ten years? For vulnerabilities to decline what should the settlement pattern look like?".

GIS, Satellite Remote Sensing, GPS

The combination of remote sensing with GIS introduces more planning information and enables more predictions to be made. The combination is frequently used for assessing and mapping of hazard and risk areas, vulnerable groups, planning of evacuation routes, location of emergency centres, as well as assessing post-disaster damage. When all these data are integrated and mapped into a common operational picture, responses can be better targeted, and priorities established. The most crucial element of GIS, and thus also the most critical barrier to its effective use is the data. The data may not be in a usable format, or at the correct scale and aggregation. Additionally the use of GIS, satellite communication and remote sensing require high bandwidth, high-speed networks and highly skilled professionals, generally scarce in most low-income countries. External assistance has been indispensable in most reviewed initiatives. The International Charter on Space and Major Disasters (ICSMD), established in 1999, provides a unified system of space data acquisition and delivery to disaster-affected communities when so requested by member agencies. It delivers high quality satellite imagery to front-line responders generally within 24 hours. In early 2009, the Charter was activated by UNDP in response to floods in the north-central and north-eastern regions of Namibia which affected 17% of the country's population. Satellite imagery showed the extent of the flooding along the Chobe River in Capribi as well as the flood changes over time. This dictated a phased return of the evacuees; the common operational picture facilitating consensus among the different agencies.Non-profit ICT-expert organisations are likewise active in providing access to satellite data to low-income countries in disaster response. TSF (*TelecomSansFrontieres*) deploys its teams and telecom equipment from one of three regional bases. These reach disaster sites within 48 hours and provide communication to emergency personnel facilitating coordination of response efforts.

Establishing Transparency and Accountability

A major disaster generally triggers an outpouring of technical and financial assistance from ordinary citizens around the world, usually channelled through donors and NGOs. The potential for waste, misappropriation and misuse of these resources is high. Lack of transparency and accountability can lead to irreversible loss of goodwill and generosity. Donors and the intended beneficiaries need to know what has been delivered where, to whom and when. Such a task is beyond the capacity of a single organisation. Self-organising, self-managed social networking tools with free and open source platforms have proven powerful in meeting this need.

Web 2.0 tools enable information sharing, collaboration and creation of user-generated content, in areas with broadband Internet connection. People serving as 'sensors', crowdsourcing 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.

In the Philippines during typhoons Ondoy and Pepang in 2009 a local web developer set up a site using Google Maps to give flood updates and locate people needing rescue. The local news networks embedded the map in their news sites and Google created a link to the website below the keyword search box for *Google Philippines*. Within a short time the site became a central hub of information on the latest developments in the flood relief effort.

Ushahidi (meaning "witness" in Kiswahili) combines SMS, Twitter and Google maps to crowd source crisis information. It is a free, open source, decentralised platform developed by Kenyan bloggers in the aftermath of the 2008 Kenyan elections but is now used in other disasters. Location-specific information is communicated directly to subscribers. Ushahidi has developed Swift River as a rapid verification system for crowd sourced information by crosschecking tagged information from different sources.

Sahana (meaning "relief" in Sinhalese) is a free and open source disaster management system developed by volunteers from the ICT community in Sri Lanka in response to the 2004 Indian Ocean Tsunami. *Sahana* architecture allows users to modify the system. It now has six modules (a) an online Bulletin Board for missing persons; (b) a Registry that keeps track of all relief organisations and civil society groups (c) a Registry that keeps track of all shelters: location, basic facilities, capacity; (d) a Central Online Repository that matches requests for aid and supplies with pledges of support; (e) a Volunteer Coordination System; and (f) an updatable Situation Awareness module. *Sahana* has been used in Indonesia, Pakistan, Philippines, China and Myanmar.

The ICT tools described here can support the earlier-described task of providing an overall operational picture but they can also help establish transparency and accountability for resource allocation decisions. However safeguards are needed against misinformation and caution must be exercised on unlimited sharing of information.

Strengths, Weaknesses and Emerging Trends

The ICT applications described above show the power of ICTs in enabling rapid, efficient and interactive communication during disasters. Fig 2 summarises the ICT tools used in response to specific information and

communication needs at particular points in climate-related disasters. Last but not the least One of the most effective mechanisms for a country to prepare for a disaster is by conducting education and public awareness programmes at the local community level.

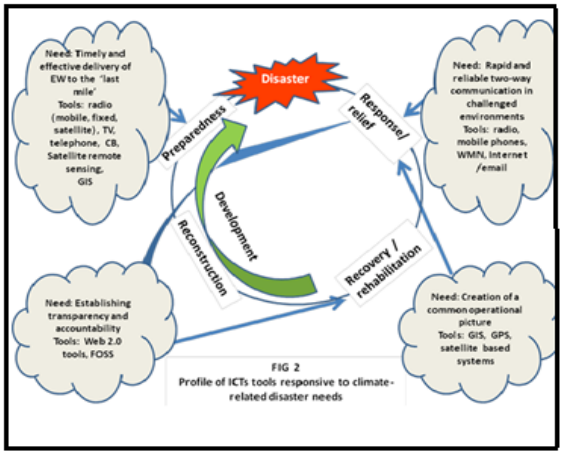

FIG 2
Profile of ICTs tools responsive to climate-related disaster needs

Figure.2

Public awareness in disaster management is a process of educating and empowering the population through sharing knowledge and information about the various types of disasters and their potential risks as widely as possible so that people act appropriately when a disaster happens.

5 Conclusion

Every country is at the risk of exposure to some type of disaster, whether natural or man-made. In order for each country to prepare for any kind of disaster, it must inform its citizens about the different types of disasters. The local residents must also be aware of how they can effectively participate in preparing for a disaster, mitigating potential impacts of a disaster and the recovery process after a disaster.One of the most effective mechanisms for a country to prepare for a disaster is by conducting education and public awareness programmes at the local community level. Public awareness in disaster management is a process of educating and empowering the population through sharing knowledge and information about the various types of disasters and their potential risks as widely as possible so that people act appropriately when a disaster happens. Disaster management is everybody's business. The impact on the lives and livelihood of peoples as well as damage to infrastructure are huge. The use of free and open source software in development is fast gaining momentumin the world. It has been successfully applied in all fields of development including disaster management. Although the concept and the practical use of free and open source software have been accepted, long term sustainability remains a concern. The ICT society now needs to devise ways and means to maintain the use of open source which has been an asset to the developing countries and particularly to the poorer communities. With the recognition of ICT as a tool for poverty alleviation and sustainable development, open source platform needs to be nurtured, especially at a time when economies round the world are on the decline. Open source could be used as an effective tool to meet the twin challenges of poverty alleviation and economic down turn. If Sahana disaster management system is to be accepted as policy for managing future disasters, respective governments need to internalize free and open source software in their respective ICT policies and accept Sahana on principle as a tool for disaster management in all future disasters in the region. ESCAP being at the center of regional development, will be in the best position to motivate the change among member states and to accept free and open source software and Sahana as an effective disaster management platform for the region.

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