Two complementary mobile technologies for disaster risk reduction through warning*

Rohan Samarajiva & Nuwan Waidyanatha

LIRNE*asia*
12 Balcombe Place Colombo 00080 Sri Lanka
e-mail: samarajiva@lirne.net, waidyanatha@lirne.net web page: http://www.lirneasia.net

Abstract : *Disaster risk reduction is a core function of government. It is possible to significantly improve this government function using mobile application and leveraging the explosive diffusion of the technology even among the poor in developing countries. Coordination within government, including communication to first responders responsible for evacuation and localized warnings, and communication to mass media who serve a critical function in public warning, can be achieved through the use of an SMS engine supplemented as necessary by an informative and robust website. Cell broadcasting can serve as an extremely useful addition to the conventional public warning methods, especially in countries with significant mobile penetration.*

Keywords: disaster risk reduction, early warning, mobiles, SMS, cell broadcasting.

1. Introduction

The loss of tens of thousands of lives in Burma (Myanmar) in the Bay of Bengal region's largest human disaster since the 2004 Indian Ocean tsunami (these events can no longer be called "natural" because, for the most part, many of the deaths are caused by human action/inaction, not by the natural hazard per se) reminds us once again of the urgency of solving the problem of the "last mile" of the early-warning chain: that of reaching the at-risk persons and ensuring orderly evacuation or other risk-mitigating actions.

The information of a powerful cyclone heading for the Ayeyarwady (Irrawaddy) delta was communicated well in time to the Myanmar authorities (Waidyanatha, 2008); the problem was that the warning did not complete the last mile to the citizens; the problem was that evacuation did not occur. The final few links of the chain were weak to non-existent. The chain broke at the weakest link, as chains do. People died, needlessly.

Citizens must be made aware through public warning. But more important is that first responders (persons in authority at the ground level, such as the Police or village leaders) must be communicated with BEFORE the public warning, so that they can organize orderly evacuations and conduct localized warning. Of necessity, media must be communicated to BEFORE the issuance of the public warning because they are the primary means of public warning (Samarajiva, 2005).

2. Mobile solutions to disaster risk reduction

There are several technical solutions for communicating to first responders and the media: addressable satellite radio, dedicated radio systems separate from public networks, and SMS. Because redundancy is correctly highly valued in the field of disaster risk reduction, there is no reason to place all eggs in one basket.

* The research reported in this paper was supported by the International Development Research Centre of Canada.

In the aftermath of the 2004 tsunami, LIRNE*asia* tested several of these technologies with a closed-user group of 32 Sarvodaya tsunami-affected villages (LIRNE*asia*, 2008). This paper discusses only one of the closed-user-group options, SMS to media and first responders, and a very good public-warning technology that has not yet been fully tested in Sri Lanka, cell broadcasting, both based on the GSM [Global System for Mobiles] mobile platform.

2.1. Closed-user-group solution: SMS plus website

Analysis of the false warning and evacuation of the coastal areas of Sri Lanka on 12th September 2007 showed that the evacuation order was issued by political authorities without the full involvement of scientific personnel. One reason the scientific personnel could not play their rightful role in assessing the evidence was the lack of proper protocols and procedures within the various organizations (Samarajiva, 2007).

In Sri Lanka, the Department of Meteorology is designated the authority for receiving tsunami hazard information from international and regional sources, in addition to their role as the nodal point for cyclone hazard information. The Disaster Management Center (DMC) is designated as the authority for issuing public warning. Therefore, the media should have been talking to the DMC and the Department of Meteorology should have been focused on interpreting the incoming hazard information and advising the DMC and the political authorities to the best of their scientific knowledge.

What actually happened was that the phones at the Department were fully occupied by journalists calling to get reliable information, preferably from the mouth of the head of the department himself. There was no time for scientific assessment of the incoming facts, including data from models showing landfall after three-four hours at least. The evacuation order was issued from the President's Office with little or no input from the scientific personnel.

One lesson to be learned from this experience is the need to develop procedures to insulate key scientific decision-makers from ad hoc news gathering at such critical times. They must be allowed to do their primary tasks in peace. The media must be provided with fast, reliable and trustworthy information that is not subject to misinterpretation (as would hurried phone calls).

The solution is a reliable, one-touch method of quickly alerting the news media using a short message service (SMS) module, complemented by an updated website that will provide greater detail. The one-touch method has been developed and is now available for any government agency in Sri Lanka or elsewhere to use, subject to a few tweaks and tests (Careem, 2008). The SMS module that has been designed is part of the Sahana disaster management software suite (Careem et al, 2006), developed in the aftermath of the 2004 Indian Ocean tsunami and deployed throughout the world, from New York City to the Philippines (Villafania, 2007). It allows government authorities to send a text message based on a pre-planned template to a group ranging from a handful to several hundred persons with one command. The numbers to which the message is sent are located in the Sahana database and can be used in the disaster relief and recovery phases as well.

One group of recipients can be pre-registered journalists; another can be the government first responders at the district level; another can be key officials and political authorities. They can be sent the identical message or customized messages. As long as the button is pressed before word of the oncoming natural hazard reaches the public, it will be effective in quickly reaching the recipients. The system is not without weaknesses, but it is extremely low-cost and it is ready for immediate deployment.

The principal weakness is inherent in SMS, which is a point-to-point communication technology (requiring switching to send messages to specific addresses). If too many SMS messages are sent at the same time (as

happens after the occurrence of a disaster) the network gets congested and the messages go through, but slowly (Prieto et al, 2004). It is similar to what would happen to the road system if all the motor vehicles in an area converge on it at the same time. The traffic would slow, if not stop altogether.

Theoretically, it is possible to build telecommunications networks capable of carrying this kind of unusual-peak traffic, as it is possible to build roads that could carry all the vehicles in a region at the same time. Both would be horrendously wasteful, because the excess capacity would lie unused most of the time and every user/taxpayer would have to bear the extremely high costs. Of necessity, networks are designed to carry normal traffic, not extremely unusual peak loads. Therefore, one has to take as given that all point-to-point networks (as opposed to broadcast or one-to-many networks) are prone to congestion. They are, therefore, unsuitable for public warning and coordination in the immediate aftermath of a disaster. SMS is a point-to-point technology to which this conclusion applies. It is based on packet transmission and is therefore a little more robust than normal circuit-switched voice telephony, but it is nevertheless unsuited for public warning and immediate post-disaster coordination.

SMS is also limited in the number of characters it can carry in one message: 140 characters. This problem can be alleviated by using workarounds such as preset templates embedded in the handsets of the recipients that are filled by the SMS. The Sahana solution does not include this feature at this time, but it can accommodate such improvements.

The short-term solution for journalists is to combine the SMS with another technology, using the concept of "complementary redundancy" developed during the LIRNE*asia* study (Gow, et al., 2007). This means that the simplicity of group SMS transmission is used to alert the recipient; the greater detail is provided through a website, which should be accessible from any newsroom (subject, of course, to it being designed to accommodate a large number of simultaneous hits, but this is not hard).

The addressable satellite radio solution field-tested for the first time in Sri Lanka by LIRNE*asia* can also serve to achieve complementary redundancy (Waidyanatha et al., 2007). However, the fixed costs of this solution are such that its deployment requires government involvement at this time.

In sum, the simple SMS module designed as part of the Sahana suite is a simple, robust solution that is ready for immediate deployment. It reaches the ordinary mobile phone that has today achieved the status of organic extension of the sense of hearing. In the same way that vision-impaired people always carry their spectacles, many are habituated to always carry their mobiles with them. It can surely be assumed that the likelihood of first responders, village leaders and media personnel carrying their mobiles with them all the time is quite high.

2.2. Public warning solution: Mobile cell broadcasting

At a discussion of public warning at a meeting of telecom operators and senior disaster managers convened by the Sri Lanka Ministry of Disaster Management and Human Rights in 2007, the operators were challenged to solve two problems. If they were solved, the rest would be easy. The two problems were:

- How to reach a passenger on a moving train (like the hundreds who perished unwarned in Paraliya on 26th December 2004 (Associated Press, 2004 December 29); and
- How to reach visitors at the rest stop on the beach at Yala, a secluded area within a national wildlife park (where dozens perished from the tsunami as well).

The reason these were considered the hardest problems was because these locations are media-poor. Today, almost all vehicles on the road are equipped with radios, though Sri Lanka's government-operated trains are

not. The country is almost fully covered by mobile signals, though in 2007 it was thought that the wildlife sanctuary was not.

The answer is cell broadcasting, a capability of mobile networks that uses frequencies other than those used for calls (such as those used to transmit base-station-location information) to broadcast or transmit in a point-to-multi-point mode. This mode is inherently immune to congestion. Radio and TV stations do not go down in the aftermath of a bombing when everyone turns on their sets; neither does cell broadcasting.

Cell broadcasting requires no addresses (numbers) and no switching. It simply broadcasts a short message to all the appropriately tuned handsets in the range of specific base stations (those of the customers of that network plus any roaming customers). Its blanketing of the coverage area of a base station is advantageous because hazards affect specific geographic areas. With cell broadcasting all the mobiles in the network in that area at that time are reached, not just those who have pre-registered as with the Sahana SMS module.

The ability to transmit warning by base-station area also allows the tailoring of messages, allowing the ordering of evacuation in one district (or cluster of base-station areas) while asking residents in another district to remain alert. It is a one-way transmission and can carry only a limited number of characters. In its current form it does not emit a ringing tone or a vibration on all handsets, leaving open the possibility of the warning reaching the phone but not the person who may fail to take it out of the pocket in time.

In the aftermath of the tsunami, it was demonstrated that this last problem can be solved by downloading Java applets into Symbian-based phones that generate unique audible alerts. The display of warnings in multiple languages has also been demonstrated, using the same Java based approach (Waidyanatha, 2007).

One may reasonably expect first responders and journalists to carry mobiles. Can the same be expected of the general public? Is the transmission of public warning via mobile unfair to the poor, especially in developing countries? The answer varies. In countries like Burma (Myanmar), where market opening and the resultant investments have not yet occurred, reliance on mobile solutions will be inappropriate. Radio and TV warnings will have to suffice. However, in many developing countries the necessary reforms have occurred. Investment has taken place and mobiles are close to ubiquitous.

For example, Sri Lanka's mobile penetration is above the half-way point. There are around 10 million active SIMS for a population of 20 million. What this means is that mobile penetration in 2008 is higher than radio penetration was at the time of the 1978 cyclone that wreaked devastation (but not too many deaths because of effective radio-based warning and good first-responder action) on the East Coast of Sri Lanka.

According to a representative survey of bottom-of-the-pyramid users conducted by AC Nielsen in 2006 on behalf of LIRNE*asia*, 22 per cent of the lowest-income households in Sri Lanka at that time had at least one mobile phone. Given the massive growth since then, it can safely be assumed that around 70 per cent of these households now have either a GSM mobile phone or a CDMA phone. The latter are actually mobiles made to look like fixed phones for regulatory/licensing reasons. They can be used while moving. With relatively simple tweaks it should be possible to enable the handsets to receive cell broadcasts and the CDMA base stations to transmit them.

The answer to the hardest problems discussed with the operators in September 2007 is cell broadcasting. It is highly unlikely for there to be a railway carriage that does not have at least a few mobile users. Except for a few patches in inland areas, signal coverage is likely to be comprehensive. The Disaster Management Center can send SMS to the driver and guard (as designated first responders) and the passengers can be warned through cell broadcasting of an impending hazard.

The secluded beach at Yala is today covered by mobile signal. With local and foreign tourists pulling out their phones to take pictures and guides exchanging information about where the animals are, the chances of reaching them through cell broadcasting are not bad, even before a technical solution to the problem of audible alerts is fully implemented.

LIRNE*asia*, in cooperation of the authorities in the Maldives, has commenced a scoping study on implementing cell broadcasting in that country. Maldives has almost reached saturation point in mobiles, with as many active SIMs as its population and all major islands and atolls covered. It is also a country that attracts large numbers of tourists relative to its population and is especially vulnerable to tsunamis because of its low elevation above sea level. The study will examine, the technical, policy and practical problems of implementing a national cell broadcast based early warning system as set out in the Maldives National Plan on Early Warning Dissemination and Emergency Communication. Once the lessons of this study are available, all ocean littoral states will be in a position to implement cell broadcasting to reduce disaster risks from rapid-onset hazards such as wind storms, tidal surges and tsunamis for their citizens as well as tourists.

3. Conclusions

Disaster risk reduction is a core function of government. It is possible to significantly improve this government function using the explosive growth of mobile technology, described as the fastest global diffusion of any technology (The Economist, 2008, May 29). Coordination within government, including communication to first responders responsible for evacuation and localized warnings, and communication to mass media who serve a critical function in public warning, can be achieved through the SMS plus website solution above. Cell broadcasting can serve as an extremely useful addition to the conventional public warning methods, especially in countries with significant mobile penetration.

References

Associated Press (2004 December 29). Disaster on Sri Lankan train. *USA Today*. http://www.usatoday.com/news/world/2004-12-28-tsunami-train_x.htm (consulted 7 June 2008)

Careem, M. (2008). Sahana messaging module. http://talksahana.com/2008/05/15/sahana-messaging-module/ (consulted 15 May 2008)

Careem, M., De Silva, C., De Silva, R., Raschid, L., and Weerawarana, S. (2006). Sahana: Overview of a disaster management system. *Proceedings of the International Conference on Information and Automation*, Colombo, Sri Lanka (published).

Gow, G., Waidyanatha, N., Anderson, P. (2007 October). Community based Hazard Warnings in Rural Sri Lanka: Performance of Alerting and Notification in a Last-Mile Message Relay, *Proceedings IEEE 1st International WRECOM2007 Conference and Exhibition*, Rome, Italy (published).

LIRNE*asia* (2008). Evaluating last-mile hazard information dissemination: A research proposal. IDRC report, dated March 1, 2008. http://www.lirneasia.net/wp-content/uploads/2008/05/hazinfo-technical-report.pdf

Prieto, A, Cosenza, R, and Stadler, R. (2004). Policy-based congestion management for an SMS gateway. Policies for Distributed Systems and Networks, *POLICY Proceedings Fifth IEEE International Workshop*, pages 215 – 218

Samarajiva, R. (2005). Mobilizing information and communications technologies for effective disaster warning: Lessons from the 2004 tsunami, *New Media and Society* (7(6); 731-47.

Samarajiva, R. (2007). Assessment of response to Bengkulu earthquake. http://lirneasia.net/2007/09/assessment-of-response-to-bengkulu-earthquake (consulted 7 June 2008)

The Economist (2008, May 29). Halfway there: How to promote the spread of mobile phones among the world's poorest. http://www.economist.com/displayStory.cfm?story_id=11465558&CFID=7536532&CFTOKEN=12674441 (consulted 7 June 2008)

Treadgold, G. (2006). Sahana: An Open Source Disaster Management System. *IAEM Bulletin* Vol 23, http://www.iaem.com/publications/bulletin/documents/200607bulletinonline.pdf (consulted 7 July 2006)

Villafania, A. (2007). IBM grant seeks to improve RP emergency, disaster response. http://technology.inquirer.net/infotech/infotech/view_article.php?article_id=61347 (consulted 19 April 2007)

Waidyanatha, N., Dias, D., Purasinghe, H. (2007). Challenges of Optimizing Common Alerting Protocol for SMS based GSM devices in Last-Mile Hazard Warning System in Sri Lanka, *Proceedings 19th Meeting of the Wireless World Research Forum, Chennai, India* (published)

Waidyanatha, N., Rangarajan, S., Gow, G., and Anderson, P. (2007). Last-Mile Hazard Warning System in Sri Lanka: Performance of the WorldSpace Addressable Radios for Emergency Alerts, *Proceedings of the IEEE 10th International Wireless Personal Multimedia Communications, Jaipur, India*, Pages 233-237

Waidyanatha, N. (2008). Cyclone Nargis – time series before, during and after. http://www.lirneasia.net/2008/05/cyclone-nargis-%E2%80%93-time-series-before-during-and-after/ (consulted 7 June 2008)