Mobile Phones and the Challenge of Sustainable Early Warning Systems: Reflections on HazInfo Sri Lanka and opportunities for future research

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Abstract

Mobile phones can play a vital role in 'last-mile' emergency alerting systems provided that communities remain actively engaged in disaster preparedness activities. While empirical observations from the HazInfo Sri Lanka project suggest that mobile phones are more easily integrated into everyday activities than more specialized technologies, access alone is not enough to sustain an adequate level of emergency preparedness within local communities. The community informatics literature suggests that interaction is more likely to be sustained through a community of practice based on effective use. This paper draws on Ling's theory of mediated ritual interaction to suggest that a community of practice might be fostered through the sharing of local risk knowledge. The mobile phone could play a prominent role in this strategy by facilitating cost-effective data collection and regular interaction in support of local risk-mapping, with the aim of improving disaster preparedness and sustained early warning capabilities at the last-mile.

Introduction

Early in the morning on 26 December 2004, seismic equipment reporting to the Pacific Warning Tsunami Center (PTWC) in Hawaii detected a massive earthquake off the coast of Northern Sumatra. Scientists working at the Center soon determined that a tsunami threat existed for the Indian Ocean and concern began grow about the need to inform people living in the region. Even though that part of the world is outside the jurisdiction of the PTWC, scientists nevertheless posted a bulletin on the Center's public website at

02:04 Zulu time (08:04 local time in Sri Lanka) warning of the possibility of a tsunami in the region.[1]

Then the waves came but it took time for them to make landfall. While Banda Aceh and places near the epicenter were struck within minutes, it was 90 minutes or more before the tsunami reached Kalmunai and other areas along the east coast of Sri Lanka. Then, for another hour a series of up to four tsunamis spread outward from the epicenter in the Sumatran Trench, traveling up to 800km/hr, destroying fishing villages and tourist resorts throughout the region. A quarter million people would eventually perish—over 40,000 alone in Sri Lanka. Yet through all of it, the world's media was mostly silent, most governments in the region failed to issue warnings, and many people had continued to go about their morning routines until disaster struck.

Many agree that the major failure of that day was not in the detection of the tsunami but rather in the ability and/or willingness to disseminate the warning to local populations. Building better detection systems is only part of the solution. The fundamental challenge going forward is how to establish and *sustain* the means to alert local populations at the community level, or what is sometimes termed the 'last-mile.'

As we will argue in this paper, mobile phones can play a key role in building sustainable last-mile early warning systems provided that they are deployed within an effective use strategy. Our argument is based on empirical observations drawn from the HazInfo Sri Lanka project—a multi-year action research study that examined the role of information and communication technologies in supporting last-mile early warning. Those observations are then examined in light of a theoretical framework that addresses the question of social sustainability through community participation.

Local warning: building and sustaining the last-mile

In spite of all the initiatives and attention paid to early warning systems since the 2004 Sumatra tsunami, there remains a persistent challenge in building and sustaining local warning capability at the last-mile. The last-mile refers to final stage in a warning system that connects individuals within local communities to urgent risk information, such as a tsunami warning.

The vulnerability of local communities is in part a function of the capability to reach individuals within these locales with specific alerts or warnings, particularly during late night or early morning hours. Dedicated systems such as pole-mounted sirens can address some of these concerns but there is ongoing uncertainty as to the level of public understanding of and response to these kinds of systems. Research on tsunami sirens in Hawaii, for example, suggests that even when they have a long history in the community, a high level of public awareness does not 'equate with increased understanding of the meaning of the siren, which remains disturbingly low' (Gregg et al., 2007). In addition,

[1] Why didn't scientists at the PTWC also call the media with this information? That question is explored at length on Doug Carlson's blog 'Tsunami Lessons' at http://tsunamilessons.blogspot.com/

maintaining specialized systems, particularly in remote areas, can be a costly undertaking for low probability events like tsunamis.

In addition, satellite and cable TV systems are often distributed from centralized head-ends located far away in major urban centres, with a limited capability for cutting into broadcasts with local information messages confined to specific geographic segments within their larger footprint. Blanketing large areas with region-wide alerts could be (and is) done through satellite-based broadcast media but over the long term it represents a counterproductive strategy that runs the risk of desensitizing local communities to these alerts, as most of the messages are not be immediately relevant to them (Partnership for Public Warning, 2003).

In one sense, then, the challenge in developing countries like Sri Lanka is not unlike that in the rural and remote parts of developed countries like Canada. Local warning capability is limited by access to communications technology and the ability to target populations with localized alerts (LIRNEasia, 2005). However, in the case of developing countries the problem is even more acute inasmuch there are serious challenges in terms of establishing a reliable source of warning messages in the first instance. More often than not, this stems from political situations that systemically hinder the development of any reliable warning system (Samarajiva, 2005).

The challenge is threefold: how to reach individuals with urgent warnings on a 24/7 basis (especially late night/early morning hours); how to reach local populations with messages that are directly relevant to them; and how to ensure access to a reliable source of warning messages. The fourth element of the challenge is how to sustain a system over the longer term, particularly when sources of funding are limited (or non-existent).

In light of this set of constraints, the mobile phone offers a promising method for last-mile warning. As an 'always-on' personal communications device, the mobile phone would at first blush appear to be an emergency alerting tool par excellence. Alerts can be targeted to specific individuals using SMS or to specific geographic locations with the use of cellular broadcast (Wood, 2006). The mobile phone is also a form of social media that enables peer-to-peer warning practices to evolve where there is otherwise uncertainty as to reliability of official sources of information. Moreover, the mobile phone is a communications tool that is easily integrated into the everyday communicative practices among individuals, thereby increasing the likelihood that it will be maintained and functioning should an alert be issued at some point in time. In other words, the mobile phone has the potential to enhance the social sustainability of an early warning system at the last-mile. This contrasts with more specialized alerting devices, which are often more difficult to maintain over the long term. The next two sections describe the HazInfo project in Sri Lanka and a set of observations emerging out of that project that appear to confirm a vital role for mobile phones in sustainable early warning systems.

The HazInfo Project in Sri Lanka

From late 2005 to mid 2008, the authors were involved in a research project in Sri Lanka intended to address concerns related to last-mile warning. The HazInfo Project was made possible with funding from Canada's International Development Research Centre (IDRC) and headed by the policy and regulation capacity-building organization LIRNEasia, along with support from several local organizations including Sarvodaya, the largest and most established NGO in Sri Lanka. A primary aim of the project was to establish and evaluate a community-based hazard warning system that would act in concert with any initiative that the national government might introduce in future.

The first step was to establish a reliable source of early warnings for tsunamis and other hazards. Sarvodaya introduced a 'Hazard Information Hub' at its Community Disaster Management Centre in Moratuwa, where volunteers were recruited to monitor various websites on a 24/7 basis for 'events of interest' that might be cause for concern (e.g., an earthquake off the coast of Indonesia). From here, information bulletins would be issued to individuals within 32 participating communities. These individuals—referred to as 'ICT Guardians' (ICT-G) by the project team—were equipped with one or more wireless communications devices that they were to maintain in good working order at all times.[2] The devices introduced by the HazInfo project included mobile phones, CDMA fixed wireless handsets, addressable satellite radios donated by Worldspace, and specialized GSM-based Remote Alarm Devices designed by engineers at the University of Moratuwa.[3]

When an ICT-G received an information bulletin over one of their devices, they were instructed to take action based on training provided to them by staff from Sarvodaya. Depending on the nature of the event, this action could range from simply informing the community about a potential risk, to initiating an immediate evacuation. In this respect, the HazInfo was not a 'public warning' system in the strictest sense, but instead a closed network for designated first responders who would in turn alert their communities through other means, including loudspeakers, temple bells, and word of mouth—a two-step flow, as it were.

Despite various technical barriers that were encountered at various stages during the project, a series of exercises conducted over the course of a year (as well as a genuine tsunami alert issued on September 12, 2007) have provided evidence to suggest that a community-based initiative like this can improve the supply of local warnings, even with minimal support from the national government (LIRNEasia, 2008). These findings are encouraging in terms of overcoming some of the inherent challenges to last-mile warning within the developing nations of the Indian Ocean region.

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[2] The ICT Guardians were also requested by the project team to keep daily journals of their experience with the technology. It was reported to me that most failed to do so.

[3] The HazInfo inventory was comprised of several desktop PCs located at the Hazard Information Hub, connected to the Internet by means of a128Kbps microwave link provided by Dialog Telecom. The field component was comprised of 10 mobile phones (Nokia 6600) with service provided by Dialog Telecom; 8 CDMA fixed wireless handsets, with service provided by Sri Lanka Telecom; 56 Worldspace satellite radios with the Disaster Warning Response and Recovery service provided by Worldspace (a transponder channel was also made available to Sarvodaya on a temporary basis for broadcasting news and information to its villages); and 15 GSM Remote Alarm Devices donated by the University of Moratuwa.

However, the local warning capability established under HazInfo began to diminish when the project came to an end. Local communities are now more aware of the tsunami hazard, but both the communication links and the general state of readiness in these communities have declined significantly in recent months. At the same time there remain unanswered questions as to the reliability of country's official public warning system. Events surrounding the September 12, 2007 tsunami warning in Sri Lanka reinforce the view held by some that numerous practical and procedural matters remain to be resolved before the national system can be considered reliable (Samarajiva, 2007).

Lessons learned from HazInfo

While the efforts of Sarvodaya and LIRNEasia were largely successful when it came to assigning responsibilities and to support training, it is not clear that the project has achieved the same success in terms of facilitating sustained engagement with those in the participating communities. As the novelty of the new technology diminished, as the hard memory of the 2004 disaster gradually recedes, and as the project and its funding came to an end in 2008, the state of readiness achieved in many of these communities has declined significantly as certain technologies fell into disuse and disrepair. This was especially true of the more specialized devices such as the satellite radio and Remote Alarm Devices (RADs).

One of the key objectives set out by HazInfo project team was to support the integration of the various communication tools into the everyday activities of the community. The view held by the project team was that integration is essential to creating long-term demand for the system and to support ongoing response readiness for future emergency incidents.

However, looking at the results achieved, it became clear that there were significant barriers to integration. On the one hand, the likelihood of the satellite radios remaining operational should have been high because they also offered access to a variety of daily information and entertainment programming to the communities.[4] Technical challenges faced by users within the communities played a role in reducing this outcome. On the other hand, the RADs were highly specialized devices using SMS technology, but designed to perform a single function. As such, even had they been more technically reliable, they were far more likely to be ignored or forgotten over time simply because there is otherwise little call for them to be used on a regular basis.

[4] Worldspace in fact made a transponder channel available to Sarvodaya for its news and information service to be broadcast to the communities over the basic tier of the AsiaStar WS satellite. The use of this channel is, however, temporary and it was reported to me that it is to cease this year. Some data have been collected on the extent of listenership in those communities where the satellite radios remained functional, but it has not been closely examined. More about Sarvodaya and its community radio initiative can be found at Alawattegama, Lara. (2008, Aug. 12). Colloquium: Sarvodaya Satellite and Web Radio as precursor to Sarvodaya Community Radio – The way forward and the challenges. *LIRNEasia.* Retrieved August, 2008. Available http://lirneasia.net/2008/08/colloquium-sarvodaya-satellite-and-web-radio-as-precursor-to-sarvodaya-community-radio-–-the-way-forward-and-the-challenges/.

Yet those communities that were given access to mobile phones and wireless CDMA handsets appear to have been the victims of their own success. At one point, Sarvodaya had to take steps to effectively manage the use of the deployed mobile phones after it became apparent that costs were exceeding the allocated budget. The problem was that individuals in the communities were apparently using the phones on a regular basis to place and receive calls, leading to phone charges that Sarvodaya was then responsible to pay. Although the phones did present some minor technical issues in terms of their alerting functions, the fact is that they appear to have remained actively used throughout the life of the project and, for a time, beyond. Moreover, there is some evidence to suggest that they were well integrated into the everyday life of the communities, serving as an important means of communications going well beyond the hazard warning function.

The lesson here is important: in contrast to the satellite radios and RADs, the wireless devices, and especially the mobile phones, offered personal access to peers, to chat and exchange information, and to maintain important social connections—often unrelated to the intended purpose of hazard warning. With that possibility now open to them, it seems that the ICT-Guardians and others in the community were far more likely to *want* to use the phone on a daily basis, to *want* to take care of it by keeping batteries charged, to *want* to keep the phone turned on at all times in anticipation of incoming calls, and to *want* to be more aware of the functional capabilities (and limitations) of the device.

Taking into account this possibility, one might be tempted to argue that the sustainable solution for local hazard warning is simply to supply every village with access to a telephone. The case of an Indian village in Pondicherry, saved from the tsunami by a phone call from a concerned relative in Singapore, validates this to a certain extent (Muthalaly, 2005). Perhaps, as with those who would look for a quick fix to other challenges related to the digital divide, the solution is simply to provide access to the technology. Put a mobile phone in the village and people will use it to send and receive alerts. Of course money must be found to pay for the service, but the view is essentially that these things will take care of themselves. However, it is important to recall that thousands of locals and tourists in other places were caught in the tsunami, many of whom were likely to have a mobile phone, thereby giving rise to the counterargument that access alone is not enough to provide assurance that people will be alerted during an emergency.

Nonetheless, in the face of wide variety of solutions available for public warning, it can be argued that findings concerning the mobile phones deployed for the HazInfo Project reveal one very important relationship in terms of access: give individuals a tool that they want to use, keep it simple, and they are more likely to use it, maintain it, and even possibly experiment with it. In other words, communication capabilities are more likely to be sustained if individuals in the community take a personal interest in them. Likewise, experience from the HazInfo Project also underscores the fact that the ‘build it and they will come’ argument is deficient with respect to sustaining a local warning system over the long term.

Going beyond access to achieve effective use

A theoretical model that goes beyond access to consider the broader social context for ICT adoption is necessary if we are to develop an actionable strategy that can lead to reliable and sustainable local warning systems. In this respect, the concept of *effective use* is helpful. Michael Gurstein, a leading thinker in the area of community informatics, adopted the term in an effort to define a more holistic, participatory approach for studying and encouraging ICT adoption:

> The ongoing process of seeing the DD [digital divide] only in terms of "access" further aggravates and perpetuates the notion that with an ICT platform there will be a relatively small number of producers and a very large, even universal, set of consumers. Meanwhile, of course, the technology is such as to allow for each to be both a consumer and a producer of information and … productive knowledge-intensive goods and services within an electronically enabled environment. … The challenge thus, is to ensure not simply "access" but "effective access" or "use", that is, access which can be used and made effective to accomplish the purposes that individuals might set for themselves. (Gurstein, 2003)

The distinction between passive consumers and active producers of information is an important consideration in light of the massive investment in sophisticated tsunami early warning systems that provide little opportunity for community's themselves to become directly involved in the management of local risk knowledge. Along these lines, the concept of effective use appears again in Gurstein's observations about the 2004 Tsunami, noting that the disaster was a prime example of the gap between access and effective use. He reminds us that information about the hazard was available but that individuals and communities in harm's way had little or no ability to make use of it. He contends that in this case 'as elsewhere, it is the "social" organization of the Last Mile which will mean whether the information is used or not and whether lives are or are not saved" (Gurstein, 2005, p. 16).

Gurstein argues that an effective use response to the 2004 Tsunami would place more emphasis on developing local capabilities to manage and use information that is currently available and, moreover, to develop community-based networks for dissemination and emergency response (2005, p. 17). Similar to a 2005 UN report that identified people-centred early warning as a future priority (United Nations, 2006), Gurstein contends that a long-term strategy must seek to develop and integrate local knowledge by cultivating extended communities of practice linked through ICTs and shared social arrangements. Similar views are now commonplace among those in the disaster research community (National Research Council, 2006).

The mobile phone and local risk knowledge as ritualistic interaction

In certain respects the HazInfo Project was well-aligned with an effective use strategy as defined by Gurstein. In fact, the project organizers had recognized from the outset that access to the technology was only a pre-condition for the long-term success of the system. To the extent that HazInfo established a basic administrative structure and provided training to the participating communities it achieved a modest level of success in going beyond access to promote effective use of technology. However, in terms cultivating an extended community of practice around local risk knowledge, the project was never able to achieve significant gains; this despite best efforts on the part of the project team to encourage local interaction by planning for a communications network that would eventually function with two-way interactions between the Hazard Information Hub and local community members.

Further empirical study is needed to understand how the enthusiastic uptake of the mobile phone as observed in the HazInfo project can be capitalized upon to foster a sustainable community of practice around local risk knowledge and, in turn, improve local warning preparedness on a long term basis.

Recent theoretical work suggests a promising line of inquiry in this regard. Ling has argued, for example, that the mobile phone can serve to reinforce 'social coherence' through the ritualistic elements it engenders within small groups (Ling, 2008b). Ling's notion of ritual is an amalgam drawn from various sources, offering a plausible approach to fostering a community of practice through mediated peer interaction:

> [Ritual] … involves the establishment of a mutually recognized focus and mood among individuals, and it is a catalyst in the construction of social cohesion. The focus is not on obsessive or repetive behaviour, although ritual interactions can take place in these settings. Rather, the emphasis is on a group process and the outcome of that process. (Ling, 2008b, p. 9)

A potentially significant research question emerging out of this claim is how to design an initiative that will encourage the formation of ritualistic patterns around the sharing of local risk knowledge such that it becomes integral to everyday communications among the ICT-Guardians within these communities. One vehicle for doing so could take the form of a local risk mapping project using mobile phones. In fact, a recent study reported by Tran, et al, on the use of GIS technology for flood risk mapping in Vietnam offers some interesting possibilities for adaptation by using mobile phones as tools for community members to produced and share risk information (Tran et al., 2008).

Tran and his collaborators share the view that 'communities have shown themselves to be a source of strength, contributing innovative ideas and local knowledge which, when mobilised and used appropriately, can lead to solutions that can make a fundamental contribution to mitigating the negative impacts of natural disasters.' Building from this premise, they conclude that 'the most successful way to do this is to engage in a process that enables local knowledge to be transferred from the mind to the map.' The mobile phone can be a valuable tool in this regard, especially when combined with the power of a digital camera and GPS functionality. ICT-Guardians could be tasked with identifying

and sharing information about local risks through both visual and textual methods as a form of 'public authoring' (Proboscis, 2008) within the context of a hazard mitigation initiative. The aim of such a project would be to promote community participation in capturing and representing local knowledge on shared maps. A key finding from Tran's study is promising in terms of this potential:

> This flood risk mapping successfully transferred unrecorded local knowledge into maps. The process of developing risk maps also mobilised the participation of the local population and succeeded in establishing trust, respect and an exchange of information among local communities and local authorities as well as local planners. This involvement assisted enormously in the development of a safer community plan.

Moreover, the results also suggest that participants experienced a level of 'mutually recognized focus and mood,' leading to greater commitment to the process and its outcomes:

> Another experience from the mapping process showed that villagers have subsequently become more aware of their risks. Incorporating existing and traditional disaster coping mechanisms of the community into the disaster management plan increased the plan's acceptance among villagers and ensured an independent commitment. Once plans have been implemented, farmers feel responsible for their involvement, since they drafted the plans themselves. This reduced the costs of external monitoring and ensure the long-term sustainability of the approach.

The authors note that 'community spirit' is a vital force in maintaining motivation, and that this may need to come from local boards or other organizations with roots in the community. By putting the data gathering capabilities into the hands of local community members with support from a coordinating body and open GIS platform, perhaps in conjunction with a community group such as Sarvodaya's Disaster Management Centre, the mobile phone might prove to be a cost effective means of generating and sharing risk knowledge.

Risk mapping would be an initial focus for the initiative but the extended benefit would derive from the social capital and 'interaction ritual' that emerges as a result of ongoing interactions among community members on risk and risk-related topics. Ling, for example, suggests that a process of entrainment might unfold when routine patterns of telephone contact between colleagues 'result in a type of solidarity …. and revitalization of group identity' (Ling, 2008a, p. 172).

Risk awareness and, ultimately, community disaster preparedness might thereby be enhanced within the community in part because members become more informed, but also because of the social capital created and sustained through the use of mobile phones in contributing to the risk-mapping project. In this sense, the local community designates working on the risk knowledge project would act as 'weak ties' or 'bridging capital' that

connects local communities to each other and to the coordinating Disaster Management Centre.

Insofar as funding constraints remain a key consideration in countries like Sri Lanka, the mobile phone offers a relatively cost-effective tool that reduces transaction costs in specialized group forming (Benkler, 2006; Shirky, 2008). Moreover, the perceived benefit of participation in a hazard information network might be further enhanced if members of the community were also to recognize the value of risk knowledge sharing to support decision-making around commonplace activities involving household and community planning. In this way the investment in a mobile phone also serves to support a social network that could reinforce local emergency preparedness within wider effective use strategy sustained through ongoing development related initiatives such as health services and local business projects (Mecheal, 2008; Overa, 2008).

Summary

Mobile phones can play a key role in building sustainable last-mile early warning systems provided that they are deployed within an effective use strategy. Empirical observations drawn from the HazInfo Sri Lanka project suggest that mobile phones are more easily integrated into everyday life than more specialized technologies. However, access alone is not enough to sustain an adequate level of emergency preparedness within local communities. The community informatics literature suggests that planners ought to work toward an effective use strategy that promotes a community of practice around local risk knowledge.

To that end, this paper has briefly examined one theoretical dimension of such a strategy by suggesting that a community of practice might be fostered through a process of ritual interaction enabled by the sharing of local risk knowledge. The mobile phone could play a prominent role in this strategy by facilitating cost-effective data collection and collegial interaction in support of local risk-mapping, thereby leading to improved disaster preparedness and sustained early warning capabilities.

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