The Role of Mobiles in Disasters and Emergencies

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Executive Summary

A spate of natural disasters and other emergencies during the past two years has prompted new interest in how technology can help enhance our security. This report assesses the impact that the widespread availability of mobile phones has had on the recovery from specific disasters and atrocities, such as the Indian Ocean tsunami, Hurricane Katrina, the summer floods in central Europe, and terrorist attacks in Istanbul and London.

The main conclusions are:

- For members of the public, the key lesson is 'text not talk' during emergencies. Text messages are more likely to get through (as they use less network capacity or can be held in a queue and sent when there is free capacity), and their use will also help ease congestion on the network.

- Public information campaigns should emphasise the role mobile phones can play in helping recover from a disaster. In the United States, for example, both the Federal Communications Commission and the local operators have posted consumer advisories, telling customers to ensure their handset batteries are charged ahead of an emergency, to have a back-up battery, to keep their phones dry, and to expect the network to be busy in the aftermath of an event such as a hurricane.

- Mobile phones tend to play a supplementary role in early warning systems, where prior surveillance, public education and a range of news media, such as broadcast television, radio and the Internet are generally the best way to prepare people for an impending disaster. Mobile phones are not currently an efficient way to broadcast information to large numbers of people, but they can be a useful mechanism for individuals to relay that information on to friends and family who may have missed the initial broadcast. In many countries, there are low-tech, but effective warning systems in place. For example, in the Caribbean, people are warned of approaching hurricanes via radio broadcasts, backed up by annual drills taught each year in schools so that people understand the warnings they are given.

- During the hours of impact of a natural disaster or terrorist attack, mobile networks inevitably experience congestion. But network data from operators affected by natural disasters such as the tsunami and floods, and by the Istanbul bombs, suggest this congestion is often similar to that seen at other peaks such as New Year.

- Operators need to prioritise calls at such times, and manage other demands on the network. Operators and governments should work together to ensure mobile networks can recover as quickly as possible when damaged, not least because many emergency services rely on mobiles to communicate with each other. Some governments may need to consider allocating more spectrum, for example, for emergency service use.

- In the immediate aftermath of a disaster the contribution of mobile is substantial thanks to the speed with which cellular networks can generally recover from damage, usually within hours or at most a few days. It is typically much easier to repair a wireless base station than hundreds of fixed-line connections. This was strikingly demonstrated in the speed of restoration of mobile services to customers in the Gulf region of the United States after Hurricane Katrina. New mobile networks can be set up relatively quickly in places where there was either no network to begin with or the original network was damaged.

- During these chaotic situations, mobile phones can help in the process of recovery. They uniquely give affected people and aid agencies the means to find and receive information specific to their needs. After the Tsunami, for example, a Sri Lankan television employee sent out text messages

containing 'on-the-ground' assessments of what was needed and where. The experience of many people in the hours and days after the Tsunami demonstrates that decentralised communication is vital for the efficient matching of resources with needs, and reconnecting dispersed people.

- Aid agencies are finding text messages and mobile calls are an increasingly important means of fund-raising, giving them rapid access to funds donated by members of the public. However, some countries impose taxes on these calls and text messages. Governments should review this policy.

- Mobile use has spread rapidly, especially in some developing countries. Some poor countries are very vulnerable to natural disasters, and many are badly affected when disaster does strike because their infrastructure and emergency response capabilities are often weak. This report looks at the contribution of mobiles using network data and other evidence. The case studies included here show that the timely spread of reliable information is a vital part of the response to and recovery from a disaster. The nature of communications needs differs at different stages of a disaster, however. The contribution of mobile (and other forms of communication) varies correspondingly. Policy debates should recognise these distinctions.

Contents

1: Introduction

Disasters and emergencies have been amongst the defining events of the past 12 months.

- The Indian Ocean tsunami of 26 December 2004 was a natural disaster of cataclysmic proportions, with a death toll of more than 280,000.
- The southern United States was hit on 23 August and again on 29 August 2005 by Hurricane Katrina, one of the most destructive and most expensive disasters in the country's history.
- On 8 October a major earthquake devastated towns and villages in Pakistan's North West Frontier province and Pakistani-run and Indian-run Kashmir, killing tens of thousands of people, and injuring and displacing many times more.
- The same day Hurricane Stan brought heavy storms and mudslides which devastated villages, causing many deaths, in Guatemala and El Salvador.
- The year also brought serious flooding in Bangladesh and India, in China, and in the countries of central Europe. In Africa severe drought affected a belt of countries across the centre of the continent.
- The all-too-frequent news of natural disaster was punctuated by other emergencies, including the terrorist attacks on Underground trains in London on 7 July and failed attacks on 21 July.

The perception that disasters and emergencies are happening more frequently is unfortunately correct. This report looks at the use and impact of mobile phones before, during and after disasters and emergencies.

There have been numerous reports and anecdotes about the uses of mobiles during and after each of the disasters in the news headlines since last year's tsunami. In this report we aim to make a more systematic assessment of the role of mobiles than was possible in the immediate aftermath of those events.

The report uses network data and other evidence to try to understand how people used mobiles and what their communications needs were in such extreme circumstances. Our research on the impact of mobiles makes it clear that the nature of communications needs differs at different stages of events, which can be characterised as follows:

early warnings
disaster impact
immediate aftermath
recovery and rebuilding

At each of these stages linked to a disaster, different forms of communication can make distinctive contributions. The following diagram (Figure 1) sets out the axtent to which people need to communicate as the timeline unfolds. Table 1 summarises how mobiles fit into the communication needs, and whether mobile can make a distinctive contribution, at each stage.

Figure 1: Communications needs at different phases of a disaster

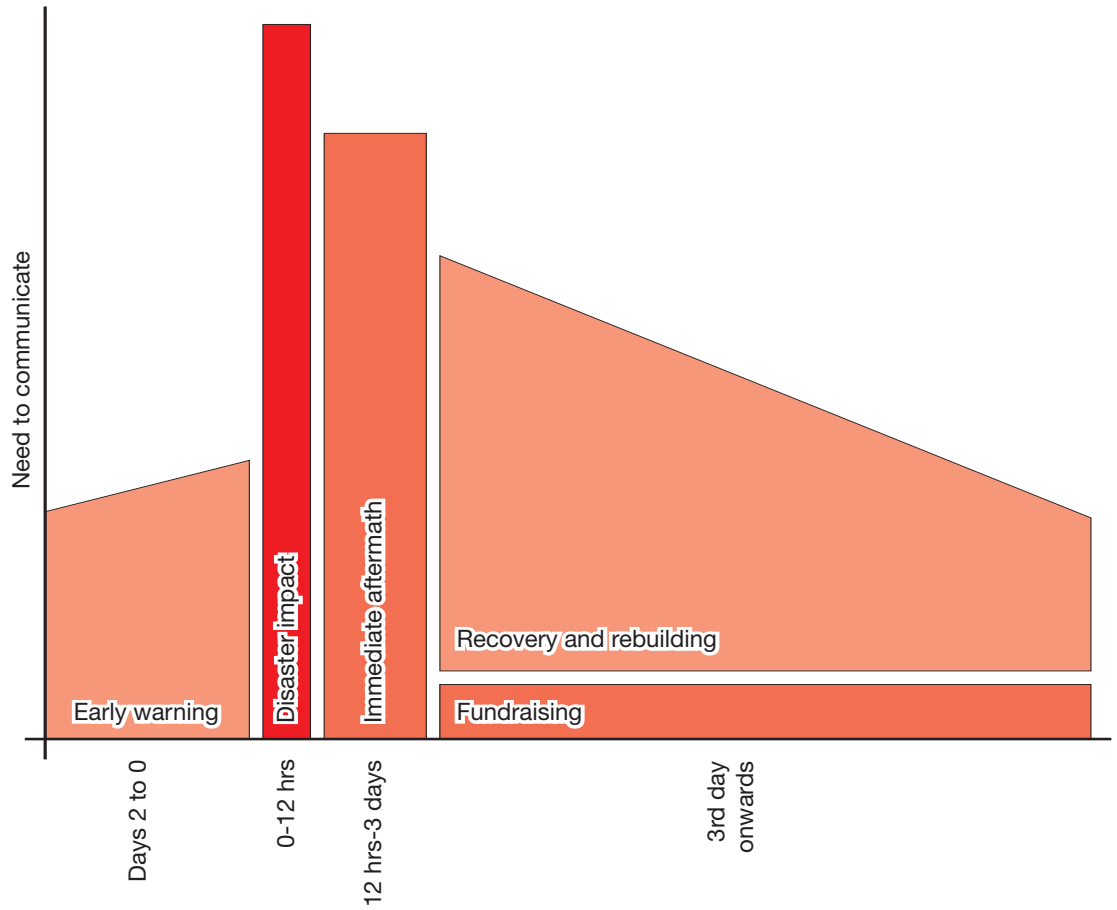


Table 1: Meeting communications needs at each stage of a disaster

Timeline:	Early Warning	Disaster Impact	Immediate aftermath	Recovery
Communications needs				
	Broadcast to as many	Emergency response –	Person-to-person	Information exchange
	vulnerable people as	emphasis on life-saving;	contact, for swift	and co-ordination;
	possible; timely,	intra-operable,	exchange of news and	dispersed 2-way
	one-way information	resilient emergency	developments; rapid	communication for as
		communications.	recovery of 2-way	many of those affected
		Public demand for	communications	as possible
		news of friends/family	amongst those affected	
			and family, friends	
Best forms of communication				
	Many, to maximise	Satellite most resilient,	Mobile, as network	Mobile (especially for
	reach: broadcast	short term, if	recovers (especially	developing countries)
	technologies, maybe	emergency services	for developing	
	supplemented by web,	have access to it.	countries). Satellite	
	backing up prior public	All forms of	for relief workers,	
	information campaigns	communications	if available.	
		available to public likely		
		to be impaired		
Distinctive mobile contribution?				
	NO:	OFTEN:	YES:	YES:
	One amongst many	Inter-operable for use	Widespread means of	Widespread means of
		by different emergency	decentralised, 2-way	decentralised, 2-way
		services (although	communication.	communication of
		may be damaged in	Network recovery often	needs. Very
		extreme circumstances).	after 1-2 days even	important in developing
		Congestion	when damage	countries with little
		management required	sustained	fixed-line alternative.
		to balance competing		
		requirements: SMS		
		more effective		

The different stages in this timeline of events, and the impact of mobile at each stage, are explored in the following sections. But to give an example here, the need in early warnings is for authoritative information to be broadcast in a timely way to as many people at risk as possible. One-to-many technologies such as radio or TV are ideal; mobile's contribution is likely to be small by comparison. On the other hand, mobile networks are capable of rapid recovery after disaster, even when they sustain damage; and they are ideal for the dispersed, two-way person-to-person communication vital to effective long-term recovery efforts. This is all the more so in developing countries where there are relatively few communications resources, but mobiles have in many cases spread extremely rapidly during the past decade.

One of the most consistent overriding messages to emerge from the research is the potential benefit of the timely spread of information in response to a disaster. While mobiles are only one element of a whole array of means of communication, the technology is especially effective at decentralising information and diffusing it rapidly to where it is most urgently needed. After looking at several recent case studies, including the Indian Ocean tsunami, Hurricane Katrina, floods in central Europe and the Bam earthquake, the conclusions identify the role of mobile at each stage of a disaster, from early warnings to long-term recovery, indicating where mobiles make their most valuable contribution, and how this might be enhanced in future.

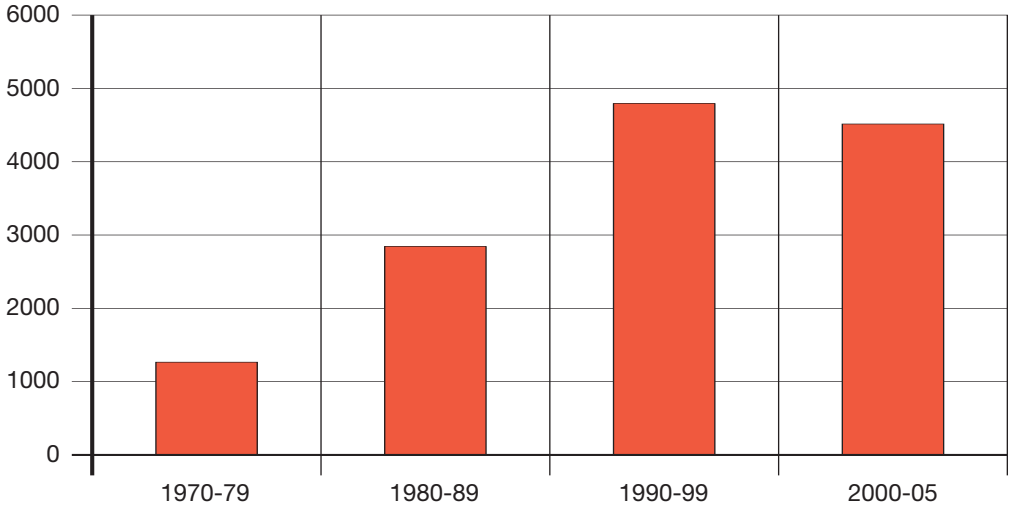
2: Background

This section sets the scene for the analysis later in this report by looking at the increasing numbers of disasters of different types, and at the death tolls and financial impacts. It also describes the extent to which mobile use has spread, to illustrate the increasing potential for mobiles as one of the tools available to respond effectively to a disaster.

The increasing number of natural disasters

The number of disasters, both natural and technological, has been climbing over time. Data on all categories (other than terrorist attacks) from the International Disaster Database, EM-DAT, show a steady increase in the frequency of natural disasters during the past 35 years, with almost as many events occurring during the past five years as in the whole of the previous decade (Figure 2). According to the EM-DAT database, there were on average 428 disasters a year between 1994 and 1998, but the annual average jumped to 707 between 1999 and 2003. Countries of low human development (as defined by the United Nations) suffered the biggest increase in the occurrence of disasters. Until the 2004 tsunami, the average death toll had been declining (from 75,000 a year to 59,000 a year in those two periods respectively); but the numbers affected by homelessness and displacement increased markedly, from an average of 213 million a year to 303 million a year.

Figure 2: Number of disasters



Source: www.em_dat.net (the OFDA/CRED International Disaster Database, accessed 7/10/05)

Disasters include: drought, earthquake, epidemic, extreme temperature, famine, flood, industrial accident, insect infestation, miscellaneous accident, slides, transport accidents, volcano, wave, wild fire, wind storm. The criteria for a disaster are: at least 10 deaths, or at least 100 people affected, or request for inter/national assistance made, or declaration of state of emergency.

Impacts of disasters: personal and financial

Both weather-related and geophysical disasters have become more common during the past decade. The Indian Ocean tsunami, the first case study in this report, is unique in modern times in the massive scale of its impact. Table 2 shows the deadliest individual disasters during 2004. In the corresponding table for 2005, the Pakistan earthquake and Hurricane Katrina will stand out. Other countries have suffered more frequent disasters with fewer fatalities in each case but many more people affected in total: China, India and Bangladesh stand out in this classification, as Table 3 shows. Developing countries tend to be more vulnerable to loss of life, and also loss of home and livelihood, than developed countries. Yet some developed countries experience a large number of extreme natural events such as hurricanes or earthquakes. In general these cause relatively few deaths and affect relatively few people.

There is usually substantial financial cost, however, due to the value of the property and infrastructure destroyed, and loss of income. The United States and Japan fall into this category, as Table 4 indicates. For example, in 2004, Hurricane Jeanne in September caused an estimated $7bn in damage in the United States, while Hurricane Ivan and Hurricane Frances in the same month caused damage of $6bn and $4.4bn respectively. An early estimate of the damage caused by Hurricane Katrina was around $200bn.

Table 2: the 10 deadliest disasters of 2004

Event	Country	Estimated deaths
Tsunami (Dec)	12 countries	280,931
Hurricane Jeanne (Sept)	Haiti	2,754
Floods (May-June)	Haiti	2,665
Tropical Storm Winnie (Nov)	Philippines	1,619
Floods (June-Aug)	India	900
Floods (June-Aug)	Bangladesh	730
Dengue epidemic (Jan-Apr)	Indonesia	648
Earthquake (Feb)	Morocco	628
Meningitis epidemic (Jan-Mar)	Burkina Faso	527
Cyclone Galifo (March)	Madagascar	363

Source: EM-DAT: The OFDA/CRED International Disaster Database www.em-dat.net
Université Catholique de Louvain, Brussels, Belgium

Table 3: the 10 most disruptive disasters of 2004

Event	Country	Estimated number of people affected
Floods (July)	PR China	33,652,026
Floods (June-August)	Bangladesh	36,000,000
Floods (June-August)	India	33,000,000
Typhoon Rananim (August)	PR China	8,594,000
Floods (Sept)	PR China	8,253,000
Drought	South Africa	4,000,000
Drought	Kenya	2,300,000
Cold wave (July)	Peru	2,137,467
Typhoon Acre (August)	Philippines	1,058,849
Cyclone Galifo (March)	Madagascar	988,139

Source: EM-DAT: The OFDA/CRED International Disaster Database www.em-dat.net
Université Catholique de Louvain, Brussels, Belgium

Table 4: the 10 most affected countries in 2004

Country	Number of disasters
PR China	25
United States	22
Indonesia	18
Philippines	13
Japan	12
Turkey	10
Bangladesh	10
Nigeria	9
Thailand	8
Russia	8

Source: EM-DAT: The OFDA/CRED International Disaster Database www.em-dat.net
Université Catholique de Louvain, Brussels, Belgium

The numbers affected by natural disasters and other emergencies are greater in low human development than in high human development countries (Table 5), although this gradient is not as pronounced in the case of death tolls in natural disasters.

Table 5: Numbers affected, per million of population, 1994-2003

	hydrometeo	geological	biological	technological
OECD	2,608	422	6	15
CEE/CIS	4,379	205	47	8
Developing	59,873	866	229	24
Least developed	29,591	120	413	14

Source: International Strategy for Disaster Reduction (ISDR). Accessed 7/10/05.
http://www.unisdr.org/disaster-statistics/impact-affected.htm

The differential impact is explained by a variety of weaknesses, including poor quality housing, inadequacy of the infrastructure and weaker emergency services in poor countries. Another important difference, however, is the inadequacy of communications networks and lack of access to information in poor countries.

All forms of disaster are on the increase

The increase in the number of natural disasters in total is mirrored in most individual categories, including hurricanes, floods and earthquakes. For example, the 2005 hurricane season has been the most severe on record, according to the United States National Oceanic and Atmospheric Administration. Researchers from the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology and the National Center for Atmospheric Research in Boulder, Colorado reported in Science that they had found evidence in satellite data of a large and sustained increase between 1970 and 2004 in the number and proportion of hurricanes reaching the severest categories, 4 and 5[1]. They write: "We conclude that global data indicate a 30-year trend towards more frequent and intense hurricanes." Hurricane Katrina is one of the case studies in this report.

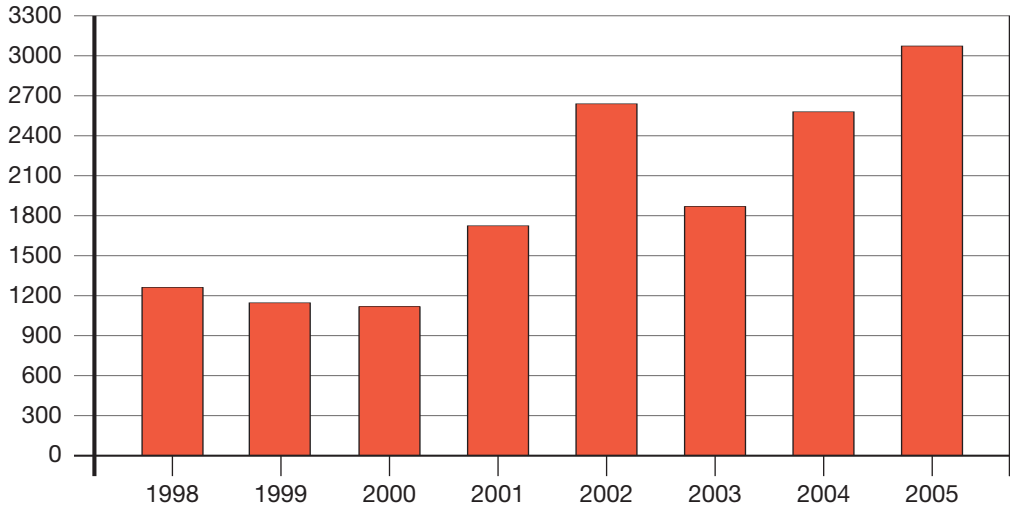
1 "Changes in Tropical Cyclone Number, Duration and Intensity in a Warming Environment", Science, Vol 309, pp1844-1846, 16 September 2005. www.sciencemag.org

Similarly, data collected by EM-DAT show a dramatic rise in the number of floods in Europe between 1985 and 2004, from between five and 10 a year in the late 1980s to 20 to 35 a year since 2000. Of the 252 flood disasters in Europe during those 20 years, 145 have occurred during the past five years.[2] The floods in central Europe in the summer of 2005, affecting the Czech Republic, Romania, Germany, Austria and Switzerland, form another of the case studies in this report.

Terrorist attacks at an elevated level

Turning to the number of terrorist incidents, figures from the Terrorism Knowledge Base show that globally these have remained at an elevated level since 2001, compared to earlier periods, as Figure 3 shows. The number of incidents in North America, Western Europe, Oceania and South East Asia has declined since 2001, despite high-profile attacks such as the Madrid train bombs on 11 March 2004 and the London Underground bombs on 7 and 21 July 2005. However, the number of attacks has remained high in Eastern Europe, Africa and central Asia, and has increased steadily in the Middle East/Gulf region and South Asia. Although the location of terrorist activity has been changing, it is plain that the level of activity and the potential threat remains high, certainly compared with the 1990s, making emergency planning vital. Responding to an extreme emergency such as a terrorist attack is obviously linked to more "everyday" emergency planning, but the scale of a terrorist incident means there are additional issues, some similar to the problems which arise in other extreme situations such as a large-scale natural disaster, and others which are quite distinct because of the security issues. We include a case study of a terrorist attack here, the explosions at the British consulate and an HSBC office in Istanbul on 20 November 2003.

Figure 3: Number of terrorist incidents



Source: www.tkb.org (accessed 7/10/05)

Increasing role of mobiles

The opening words of the 2005 World Disasters Report published by the International Federation of Red Cross and Red Crescent Societies, by Secretary General Markku Niskala, are: "Looking back over the events of 2004, it is striking how many of the year's disasters could have been avoided with better information and communication." Although this report does not consider the role of mobiles in detail, it notes that personal use of mobiles in the case of the tsunami helped compensate for the absence of official information, as part of a person-to-person communication effort which was more open and effective than information provision by either relief organisations or official agencies.[3]

2 "Flood Disasters in Europe: a Short Analysis of EMDAT data for Years 1985-2004", Philippe Hoyois, Debarati Guha-Sapir, WHO Collaborating Centre for research on the Epidemiology of Disasters, Catholic University of Louvain.

3 WDR2005, p12.

As the report notes, mobiles have been playing a part in disaster response for a few years. An early example was the 2001 earthquake affecting the Indian state of Gujarat: a local women's union, the Self-Employed Women's Association, distributed 200 mobile phones to its staff and volunteers to stay in touch with each other and headquarters as they travelled from village to village assessing and reporting needs. But the IFRC report concludes that the Tsunami probably marks a"tipping point" in terms of the effectiveness of person-to-person communication in disaster response.

The information-poverty of developing countries has helped make the impact of mobile all the more powerful, as mobile penetration (i.e. number of subscribers per 100 people), which is on a rising trend everywhere, has increased even more rapidly in poor countries. The average annual growth rate in the number of subscribers was over 30% in Asia and nearly 50% in Africa from 2000 to 2004. While Africa still lags behind other regions in mobile penetration rates, there are now on average 9 mobile subscriptions for every 100 inhabitants. Africa has been the fastest-growing mobile region in the world, but there has also been rapid growth in Asia and Latin America. The available evidence is that mobile communications are highly valued in these poorer regions, where, as Table 6 shows, other forms of communication are also sparse.

Table 6: Indicators of communications access, major regions of the world

Continent	Mobiles/100	Fixed lines/100	Internet users/100	Radios/100
Africa	9.0	3.1	2.6	19.8
Asia	18.9	14.4	8.3	11.2/28.7*
Americas	42.4	33.9	30.7	41.1
Europe	71.5	40.4	31.9	44.7/81.2†
Oceania	62.7	41.0	51.8	126.0
World	44.1	19.0	13.8	41.9

Source: ITU, figures for 2004. Radio figures, World Development Indicators database, accessed 9/11/05
**S Asia and E Asia respectively; †CEE/EU respectively.*

Mobile penetration rates vary widely between developing countries. For example, mobile penetration in Pakistan is low, at 3.19 per 100 (At the end of 2004), and in India at 4.37 per 100; in Indonesia the figure is 13.48 per 100 and in the Philippines 39.85. (For comparison, the mobile penetration rate is 71.5 in Europe and 60.97 in the United States.) Nevertheless, many villages in other poor regions such as Africa, southern Asia and southern and central America now have access to mobile telecommunications. In developing countries access to mobile communications can be much greater than these figures indicate, though, thanks to the sharing of handsets especially in rural areas.[4] According to the ICRC: "Relief and risk reduction have been revolutionized by mobile phones."[5] The importance of mobile communications in the information-poor context of developing countries enhances their potential contribution in disasters, even greater than in the developed world with its richer infrastructure.
We turn now to a series of case studies to look for greater insight into what the contribution of mobile has been in recent disasters.

4 See Africa: The Impact of Mobile Phones, Vodafone Public Policy Report no 2, March 2005. http://www.vodafone.com/africa
5 WDR2005, p33.

3: The Indian Ocean Tsunami, 26 December 2004

The tsunami which followed two massive undersea earthquakes in the Indian Ocean on 26 December 2004 was one of the worst natural disasters of modern times. The quakes were of magnitudes 9.0 and 7.5 on the Richter scale, just over four hours apart. The disaster evoked a massive national and international relief effort. Thousands of foreign aid workers poured into the disaster zones during the following days and weeks, bringing amongst other supplies sophisticated phones, radios and computers. South Asia is a region with relatively low access to communications, although the affected countries vary widely, as Table 7 shows. Many of the most seriously affected countries rely especially heavily on mobile networks – the proportion of all phone subscribers using mobile ranges from 52% in India (close to the Asian average) to over 80% in Thailand.

Table 7: Indicators of communications access, tsunami-affected countries

Country	Mobiles/100	Fixed lines/100	Internet users/100	Radios/100
India	4.4	4.1	3.2	12.0
Indonesia	13.5	4.5	6.5	15.9
Maldives	34.5	9.6	5.8	na
Sri Lanka	11.5	5.1	1.5	21.5
Thailand	44.1	10.6	11.3	23.5
Asia	18.9	14.4	8.3	11.2/28.7*
World	44.1	19.0	13.8	41.9

*Source: ITU, figures for 2004. Radio figures, World Development Indicators database, accessed 9/11/05 *S Asia and E Asia respectively. Other affected countries were: Bangladesh, Kenya, Malaysia, Myanmar, Seychelles, Somalia, Tanzania.*

Banda Aceh

It was in Banda Aceh that the destruction of the infrastructure was most severe. Closest to the epicentre of the earthquake, the disaster destroyed many masts and network switches. Many survivors lost their mobile phones in their rush to safety. Local residents, aid workers and journalists were all seeking access to the limited capacity. Telecommunications collapsed completely for a time. The first information to emerge was footage filmed by a private Indonesian TV station, Metro TV, which could not be sent until some communications were restored the next day, 27 December. Reporters from the Australian Broadcasting Corporation and Al Jazeera arrived that day too, and their pictures ensured emergency workers followed in their thousands in the next few days. The TV crews used satellite technology, while the next means of communications to be restored was SMS messaging.

Within a day, repair efforts had begun. For example, Nokia flew in crews to start the reconstruction of the mobile network. Within another day it had rerouted base stations on their way to other destinations, and reconfigured them to fit the pre-existing network. Also on the first day after the tsunami struck, Nokia delivered the first phones and technical support to relief agencies, primarily the Red Cross/Red Crescent. Sweden's Ericsson AB was also present within a day to help rebuild the mobile network, donating 10 radio-base stations for Banda Aceh's network along with hundreds of mobile phones and technical staff. The company also donated 1,300 mobile phones and a team to restore communications in Sri Lanka. Many operators took steps to offer assistance. For example, Turkcell called more than 2,000 post-paid and prepaid subscribers in the affected areas between 26 and 28 December. Turkcell sent SMSs with Turkish consulate contact details, Turkish Airlines and other airline addresses and flight details and other helpful information. Turkcell also gave free phones and minutes to several aid groups from Turkey which went to disaster areas. Aid workers said at least some of the additional mobile network capacity built in the wake of the disaster would remain behind after they had left.

Relief workers, in conjunction with mobile operators and manufacturers, now set up as a matter of course sophisticated wireless networks in disaster zones such as Banda Aceh. So important has post-disaster communication become that information was the main theme of the 2005 World Disasters

Report from the International Federation of Red Cross and Red Crescent Societies. The report argues that the flow of information about survivors' needs is vital to the relief effort, but it notes that there is an urgent need for better co-ordination of information amongst the relief agencies. In some areas there was a glut of agencies, often providing unnecessary or duplicated supplies, whereas in others relief efforts were inadequate. There was a real risk of chaos in the relief effort. The report is highly critical of what it portrayed as an unseemly competition between agencies in some of the affected areas. It concludes: "Emergencies are confusing, chaotic, fast-changing environments where rumour often plays a more powerful role than fact. Aid agencies focus mainly on the 'hardware' side of a response – rice, pumps, trucks – but neglect the invisible component."

At the same time, it notes that efforts involving the decentralised use of information by survivors were often more effective. It contrasts the situation in some of the affected areas such as Banda Aceh, where multiple competing agencies actually hoarded information in a turf war, with the Maldives, heavily reliant on its cell phone network. The tsunami killed 10 people, but left 300,000 affected through the destruction of their homes, with 80 islands badly damaged or uninhabitable. The tsunami brought the network down for a week, so early relief efforts were co-ordinated centrally by the government, involving just six aid agencies. When communications were restored, local chiefs started to call in with their own needs assessments, which provided the relief workers with the information they needed to direct the right supplies to the right places. Banda Aceh and the Maldives perhaps reflect the extremes in terms of post-tsunami information flows.

The World Disasters Report urges future relief and recovery efforts to concentrate on improving the flow of information and in particular the distribution of mobile phones to survivors. It says: "Disasters are times of great uncertainty, and this uncertainty may be the most painful part of the experience." The aftermath of the tsunami was remarkable for the extent and speed of communications mainly via SMS and weblogs. Although these capabilities, which of course are informal and individual communications, have been growing for years, the response to the tsunami brought them great public visibility. The tsunami was the first disaster of global scale that used the kind of onsite-to-global-and-back-again powers that ad hoc networks of mobile phone and internet users can provide.

Members of the public in many countries used their blogs to publish and publicise photographs, reports, lists of people and lists of and needed resources, deriving their information from mobile voice and text messages, directly from the many scenes of the disaster. SMS messages were particularly useful as messages can often get through even when the network can not meet demand for voice calls. For example, a Sri Lankan television employee was one of the first following the disaster to send out text messages about the latest news and on-the-ground assessments of what was needed and where. His messages were posted on the weblog Dogs without Borders. Both SMS messages and blogs are an extremely dispersed and informal form of communications, and although vulnerable to confusion and rumour, were clearly accessible and valuable to many of those caught up in the disaster in some way.

Mobiles are especially important in developing countries such as Indonesia where there are barriers of literacy and web access in many communities.[6] What's more, in developing countries like those affected by the tsunami, mobiles have overtaken fixed lines and are in some cases more prevalent than broadcast communications too. Given the relative speed with which an emergency network can be installed and pre-existing networks restored, compared to other parts of the infrastructure, mobiles can play a distinctive role in the long process of recovery, ensuring information does flow where it is needed. Almost all of the affected regions did see mobile coverage restored within days, if it had been interrupted at all.

6 See WDR 2005 especially Chapters 4-5.

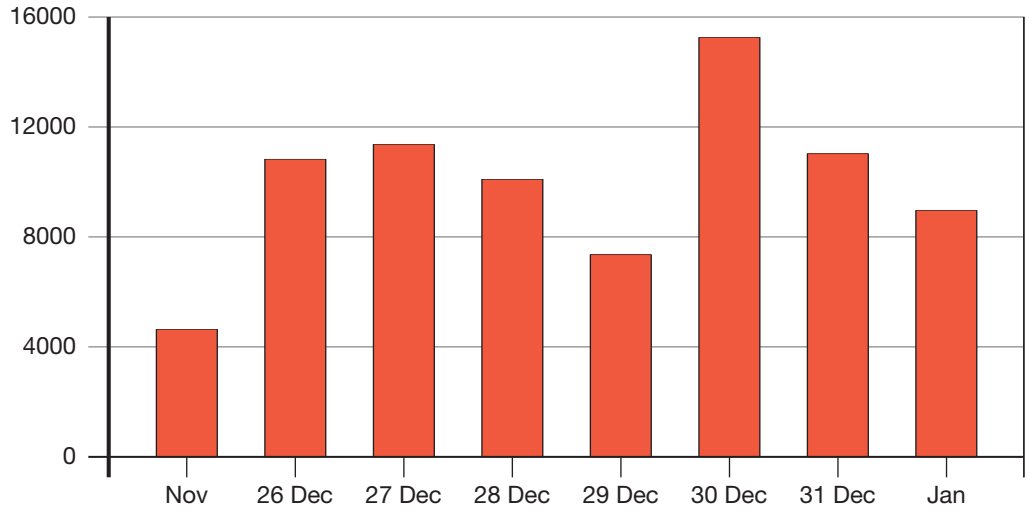
Tamil Nadu

In southern India, hundreds of villages along more than 1000km of coastline were affected. The human and physical impact was less severe than in places closer to the epicentre. The toll of the dead and missing in India (including the Andoman and Nicobar Islands) nevertheless reached more than 16,000.

Using network data provided by Bharti Tele-Ventures and Aircel covering the affected areas in Tamil Nadu, it is possible to assess the impact of the tsunami on mobile communications. Bharti, based in New Delhi, is India's largest GSM provider, while Aircel Cellular, founded in 1999, is one of the leading operators in Tamil Nadu. The major city in the region is Chennai, and many aid agency workers poured into the city in the weeks following the disaster.

Neither operator suffered physical damage to their network during the tsunami, so their main issue was ensuring there was sufficient capacity to meet the surge in demand. The tsunami occurred on a Sunday, when usage is typically 25% below the weekday average. In the aftermath, the increase in usage was 25-30%, in cells in the affected area, for the two operators. In addition, both networks took the precaution in the following days of activating 'half rate' on the network, whereby capacity can be doubled through data compression (with a resulting loss of quality) Both networks were therefore able to cope with the increased demand. Figure 4 below shows the impact of the tsunami on call volumes in the district of Nagapattinam, with a marked increased compared with the preceding level. There was a further peak on the 30 December. Call volumes stayed higher after the tsunami than before: in this district they were 89% higher in June 2005 than they had been six months previously.

Figure 4: Incoming calls, Nagapattinam



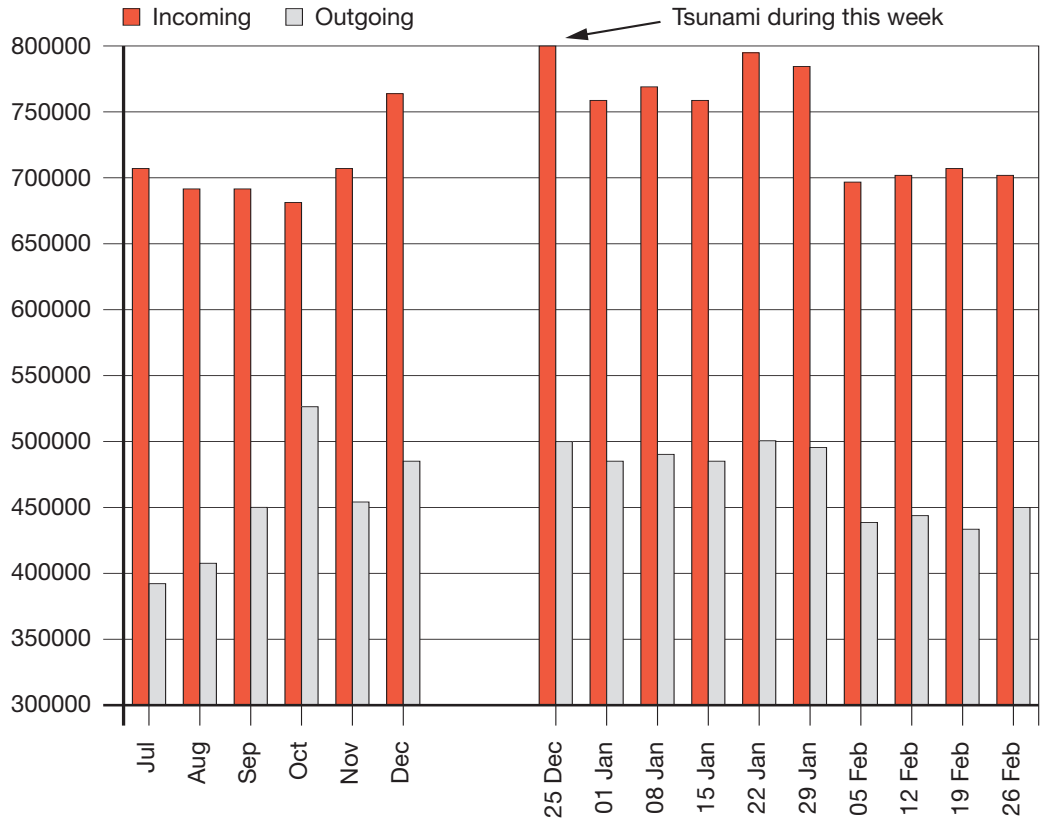
Source: Bharti TeleVentures

A sustained level of increased demand is also revealed in call volumes for the whole of the affected area in Tamil Nadu, for both operators. (Data for SMS volumes were not captured from the whole network for the post-tsunami weeks.) The increase was not very large in percentage terms, especially for incoming calls, but rises of up to 30% higher than the normal level were sustained for a few weeks, in the context of an upward trend in call volumes during the preceding months in any case. It seems possible that the presence of numerous aid workers in Chennai contributed to this pattern of elevated call volumes for several weeks. It is also noteworthy that increase in tsunami-related SMS volumes was smaller than the

7 This came against the background of strongly growing demand. Both Aircel and Bharti had experienced significant growth in their subscriber base during the preceding months. India is a rapidly growing mobile market, with the number of subscribers growing by more than 90% a year in the past five years, reaching more than 47 million in 2004.

New Year peak. Also striking is the high ratio of texts to voice calls, almost two to one. Although in some low and middle income markets literacy can be a barrier to the use of text messaging, income effects make texts more attractive, where literacy does not inhibit it.[8]

Figure 5: Incoming and outgoing calls, all affected areas including Chennai



Source: Aircel. Note, December average will include tsunami and the following 5 days.

The remainder of this section looks at three specific aspects of the role of mobile relevant to the tsunami: early warnings; fund-raising efforts; and emergency restoration of telecommunications.

8 See Africa: The Impact of Mobile Phones, http://www.vodafone.com/africa, for a discussion of this phenomenon in rural South Africa and Tanzania.

3.1: Disaster Alert Schemes

Prior to the tsunami, there had already been a substantial amount of work on emergency alert schemes. In many parts of the world there are already warning systems, usually based on broadcasting via radio and television, or even direct person-to-person warnings like the hurricane warning schemes in place in the Caribbean. Of course, the tsunami led to redoubled efforts to put in place improved schemes. Some of the effort concerned implementing a tsunami-warning framework in the Indian Ocean, similar to that already operating in the Pacific. Other schemes focus on the communication of warnings to the many individuals who might be affected.

The key to effective early warning is the transmission of authoritative information to as many people as possible, so although the broadcast media are best placed to do this, there has been interest in using additional methods of communication to supplement existing systems. Although these are unable to match the reach of mass media broadcasting, they may extend the coverage of warnings to some degree. One of these new technologies is provision of detailed information on websites.

Another is the use of mobile phone networks, which may offer some advantage in being able to target particular locations or groups of subscribers. Both individual operators and the GSM Association have therefore been involved in discussions on effective warning and response efforts. These can be divided into the national, regional and global. Many involve multiple operators working co-operatively with each other and the relevant authorities. There are also several initiatives taken by individuals and organisations not directly involved in the mobile industry, including local authorities in many parts of the world. The principal technological approaches are cell broadcast and SMS messaging, each of which has different merits. The cell broadcast approach alerts everyone in the targeted cells, which can range from an individual cell to the entire country, but requires preconfiguration of handsets. SMS messaging targets categories of individuals, including outbound roamers; while it may be less closely tailored geographically, it is ubiquitous, very familiar to users and has a proven impact on people's responses.

There are examples of both kinds to be found in national initiatives. For example, in the Netherlands there is a two-year pilot cell broadcast scheme involving three operators, Vodafone, KPN and Telfort. Warnings to mobiles in an area affected by danger will be added to existing means of communication, namely warning sirens and emergency TV and radio broadcasts. Trials began in October 2005, starting in Zoetermeer, Amsterdam and Zeeland. The United States is considering adding wireless technologies to the existing nationwide Emergency Alert Scheme; it is likely to involve all the mobile operators and use SMS messages. India is considering a cyclone warning scheme in coastal states, in which GSM operators will use both cell broadcast and SMS. National authorities of course remain at the forefront of initiatives to prepare their own citizens for emergencies.

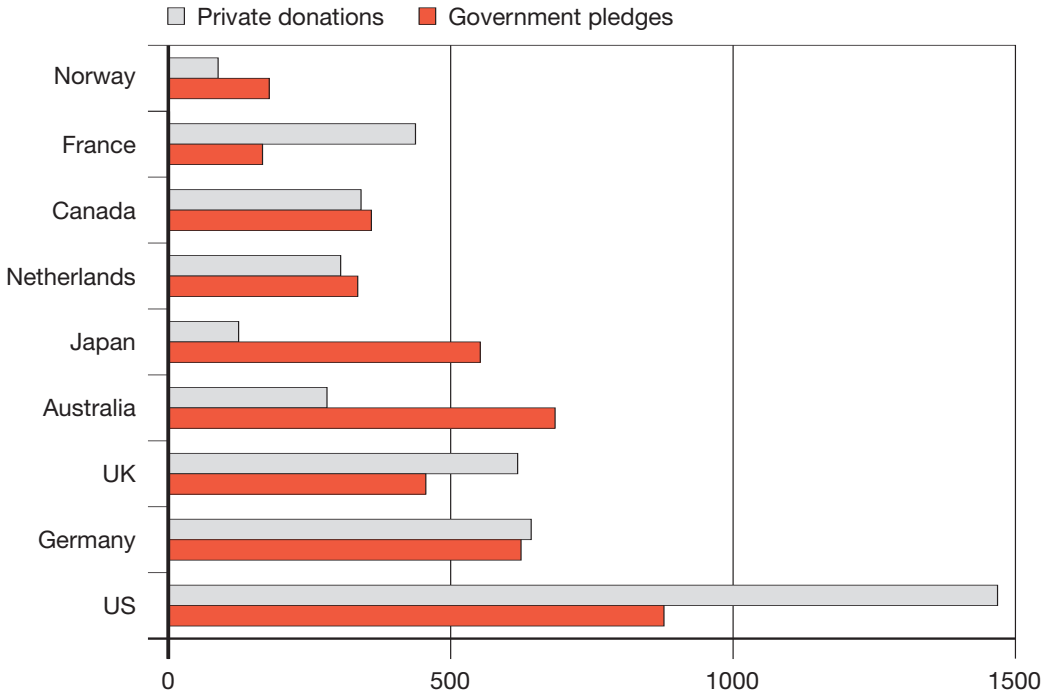
At the regional level, the Indian Ocean Tsunami Warning and Mitigation System came into being on 30 June 2005, under the aegis of Unesco's Intergovernmental Oceanographic Commission. The ASEAN countries have also set up a task force since the tsunami to develop a means of disseminating earthquake information. Indonesia has taken the lead and the first meeting was held in Jakarta in July. The Caribbean has a long history of hurricane warning schemes. It set up the Caribbean Disaster Emergency Response Agency in 1991. Existing warnings rely on a mixture of technology and person-to-person transmission of messages. CDERA is looking at adding SMS messages to its methods, perhaps through an opt-in subscription list.

It is apparent from looking at the wide range of discussions of early warning schemes, however, that effective warnings to people at risk are likely to involve several technologies. Mobile has some useful characteristics, but its contribution is unlikely to be significant compared to broadcast technologies which can also be used to cover geographically targeted areas, or direct warnings such as sirens. The reason is that the essential characteristic of a good early warning scheme is communicating one-way, authoritative information to those in the threatened area, whereas mobile is a decentralised, two-way communications technology.

3.2: Mobiles and Aid Efforts

After the tsunami, there was a massive response to appeals for funds from many countries, and aid agencies poured people and supplies into the affected areas. One of the most striking aspects of the response was that members of the public in many cases gave almost as much as their governments. In some instances – the United States, the UK and France, for example – they have given much more.

Figure 6: Largest tsunami relief donors, $m



Source: Reuters AlertNet. http://www.alertnet.org/thefacts/reliefresources/112739777749.htm accessed 11/11/05. Site also gives per capita figures. See also http://www.members.alertnet.org/thefacts/aidtracker/. Figures do not include loan facilities made available by governments, but do include loans actually extended. Government figures are pledges, and will be disbursed over a number of years. Private figures are donations.

This is important because private donations are more reliable than official pledges of aid. For most major disasters the United Nations makes a consolidated appeal, amassing the needs identified by all its agencies in collaboration with the affected communities. However, these requests are rarely met in full, and the amounts delivered are usually only a fraction of the totals pledged. For example, the Bam earthquake in Iran, on 26 December 2003, saw $1bn pledged by January 2004, but just $116m disbursed by December 2004. UN estimates indicate that between 23% and 45% of funds it has requested for disaster relief during the past five years have not been pledged in any case.[9] Amongst private donations, the funds pledged by phone are the most reliable of all because they happen immediately.

Donating by text in particular has tapped an important new source of relief funds, as individuals respond immediately to appeals, sometimes prompted by messages from their service provider. Donations are small, limited by the maximum charge for a premium SMS message. On the other hand they tap into donors who are much more likely to act spontaneously, without the forethought and effort needed for many other means of giving money, and also reach groups such as students who can only afford to give small sums.

9 See Smoke and Mirrors: Deficiencies in Disaster Funding, Peter Walker, Jennifer Leaning, Larry Minear, BMJ2005; 330; 247-250.

Charities have concluded this method of fundraising is not merely cannibalising other forms of giving, and an increasing number are turning to SMS fundraising. Each country has its own distinctive regulation, charging and tax treatment of SMS services. Donors have mostly become aware that a network charge will be deducted from their SMS gift, just as they realise they will pay the call charge if donating by phone call or buy the stamp if posting a letter. The tax treatment of donations by voice call or text varies: tax may be levied on call or message charges, although some authorities waived this for tsunami relief efforts. The tax relief on donations by mobile, especially by SMS, is not consistent with the relief available on other forms of donation in many countries.

Nevertheless, it is likely that fundraising by mobile will grow in importance. The aid agencies recognise the immediacy and reliability of the mechanism. Telecoms operators themselves are playing an increasingly active part, a recognition of their central role in the communications network which links the modern world.

UNICEF – Utilising the power of SMS

Children's agency UNICEF (United Nations Children's Fund) uses SMS technology to raise funds for disaster response and relief and is a strong advocate of the role of mobile services in emergency situations.

"SMS is an important tool to help emergency response, and it's going to become increasingly important," says Per Stenbeck, International Fundraising Director at Unicef. "It's a definite complement to traditional fundraising techniques and provides a potentially immediate method of donation."

The success of SMS technology in fundraising is proven. €27 million was donated in just a couple of weeks in Italy following the December 2004 tsunami emergency .

SMS fundraising initiatives have now been launched in most Western European countries,. Such services have raised millions of euros for emergency relief, aiding victims of the Asian tsunami and the Iraq conflict, amongst many others.

UNICEF believes that the use of SMS technology has given it the opportunity to increase levels of fundraising from certain segments of the market, for example, the youth sector. In future, the agency is also hopeful that donators will be able to pledge varying amounts, rather than the current fixed donation of €1 per SMS.

"One of the fundamental principles of fundraising is to make it easy for the donor," comments Stenbeck. "Nothing is easier than SMS giving."

Despite the advantages, Stenbeck warns that SMS donations are treated as standard text messages by tax authorities, meaning a percentage of the donation can be lost as tax. "Some countries have waived VAT on SMS donations but not all. The amount of VAT charged also varies from country to country."

Per Stenbeck
International Fundraising Director
Unicef PSD - Geneva

3.3: Telecoms Restoration: the Bam Earthquake

Specialist relief organisations in partnership with local operators can restore telecommunications services as little as 24 hours after a disaster. One of the first examples was the partnership between Turkcell and Ericsson Response in Bam, Iran. An earthquake registering 6.5 on the Richter scale hit the ancient city of Bam, a 1,00km south-east of Tehran, during the early hours of 26th December, 2003. The dead numbered 26,271, an estimated 30,000 were injured and 75,000 were made homeless. In the days following the earthquake, the Iranian authorities, with help from the International Red Crescent Society, launched a massive rescue and relief operation involving more than 1,600 aid workers from 44 countries.

Turkcell, Turkey's largest GSM operator, and Ericsson Response established communications in the disaster area within a day of the earthquake, responding to the request of the Iranian authorities. Volunteers from Ericsson Response and colleagues at Ericsson Turkey and Ericsson Iran were sent to install an emergency GSM system which was connected via satellite to Turkcell's network. The project came under the umbrella of Turkcell's unique Emergency Communication System project. This project was launched in response to the devastating August 1999 earthquake at Izmit in the Marmara region, which claimed thousands of lives and destroyed much of the city. According to the United Nations Development Programme, Turkey and Iran are two of the countries most vulnerable to the impact of earthquakes.[10] Turkcell's project was designed to solve communications problems that crisis management and rescue teams tend to face after natural disasters. Immediately after a disaster, the system is transported to the area affected, staying operational as long as needed. The development of the system was completed in 2002 and put to the test in Bam a year later. In addition to the mobile network, Turkcell and Ericsson provided one radio base station, three mobile base stations, ten generators and satellite equipment.

The network installed in Bam was operational for 10 days, until local networks were repaired. In addition to the mobile network, Turkcell and Ericsson provided one radio base station, three mobile base stations, ten generators and satellite equipment. Ericsson Iran was in contact with local authorities and conveyed the initial request for assistance to Turkcell. The GSM system was operational within 24 hours after its arrival in Bam. Technical staff from Ericsson Iran were responsible for the operation of the system in cooperation with Turkcell engineers. Sony Ericsson Turkey supplied 150 phones and Ericsson Response also donated 240 mobile phones. Ericsson Response coordinated activities with IFRC (International Federation of Red Cross/Red Crescent societies), SRSA (Swedish Rescue Services Agency) and other relief organisations. The UNDAC (United Nations Disaster Assessment Coordination) team received 50 mobile phones from Ericsson, which were distributed to UN agencies and NGOs present in the field. Additional mobile phones were provided to local authorities, IRCS and IFRC staff and it was agreed to create a local humanitarian phonebook.

Télécoms sans Frontières (TSF) also responded to the Bam earthquake by setting up a centre to help other NGOs to co-ordinate their relief efforts. The group set up a data transmission and Internet connection incorporating satellite operator, Inmarsat's mini-M units for voice communications and regional BGAN terminals for high-speed data communications. The centre was geared towards allowing local and international organisations to communicate with their head offices and enabled them to co-ordinate their activities more easily. A humanitarian telecoms centre for local people was opened on December 30 so survivors could make phone calls to friends and relatives in Iran and abroad. The group was born out of the conflict in Kosovo in 1999 (and inspired by the example of Médecins sans Frontières).

As this example demonstrates, mobile telecommunications make an important contribution in the immediate aftermath of a disaster, but rapid restoration of the network is essential to take advantage of the distinctive benefits of mobile. Projects like Turkcell's Emergency Communication System and organisations such as Ericsson Response and TSF have that speedy network restoration as their central role.

10 Reducing Disaster Risk, UNDP, 2004. The report combines a measure of the physical prevalence of earthquakes with an assessment of the impact of tremors.

So important is telecommunications restoration in disaster response that Ericsson Response is now the fourth organisation in the chain of international emergency response, after the UN Office for the Co-ordination of Humanitarian Affairs (OCHA), the World Food Programme and the Red Cross.

Ericsson – Responding to Disaster

Established in 1999, Ericsson Response is a global initiative aimed at developing a better and faster response to human suffering caused by disaster.

"Mobile technology can definitely help save lives," says Dag Nielsen, Director, Ericsson Response. "We are giving tools so that the humanitarian relief effort can be improved. If you have better tools, the whole relief effort can be enhanced."

In partnership with the United Nations World Food Programme, the Office for the Coordination of Humanitarian Affairs and the International Federation of Red Cross and Red Crescent Societies, Ericsson Response provides mobile equipment, as well as people to implement and operate it, to areas affected by both natural disasters and complex disasters.

Ericsson Response' services were first called into action following earthquakes in El Salvador and India in January 2001. Since then the initiative has been involved in all major natural and man-made disasters.

"We work with the humanitarian organisations in each affected country to help them with their relief efforts," comments Nielsen. "We're helping to bring the power of mobile technology and resources directly to the service of humanity, and, in particular, humanitarian relief operations. The future development of new mobile services will also help speed up the process of recovery."

Dag Nielsen
Director Ericsson Response (Ericsson)

Summary

There are four key points about the impact of mobile illustrated by the case of the tsunami:

- Mobile networks can be restored very quickly even when damaged or destroyed in such an immense catastrophe. Telecoms relief organisations and operators play an important role in this process, which is vital in developing countries in which mobiles have in recent years come to form a mainstay of the communications infrastructure;
- Mobiles permit the decentralised flow of communications which is so important for the process of recovery.
- Mobiles have started to play an important role in raising private sector relief funding, and the tsunami seems to have been a milestone in this respect.
- Despite all the attention being paid to the use of mobiles in early warning schemes, their contribution in this role is not distinctive, compared to other available technologies.

The Red Cross – Mobilizing the Power of Humanity

As the world's largest humanitarian organization, the International Federation of Red Cross and Red Cross Movement is well placed to highlight the beneficial effects mobile technology can have on areas affected by natural disasters.

The Federation has partnered with Ericsson for the provision of mobile phone technology to assist in disaster response and disaster preparation. "For major disasters we mobilise staff and volunteers to fly into disaster zones and set up IT and telecommunications services," says Hugh Peterken, head of IT at the International Federation of Red Cross. "We are closely involved with Ericsson Response. Ericsson provide a number of services to us, ranging from donation of mobile phones to providing people to help with training."

Over the past few years, the partnership has provided communications equipment and services during operations in Afghanistan, Algeria, Belize, the Dominican Republic, El Salvador, India, Peru, Southern Africa, Tajikstan, Tanzania and Vietnam.

"Mobile technology can certainly help in the response phase," explains Peterken. "We have used mobile phones to allow affected families to re-establish contact or confirm to relatives that they are safe. That is a very useful part of the response. The next part is recovery. In that phase, mobile technology is very much used as a business tool. Its value there is well known. There is a general efficiency gain from having people connected through mobile phones."

As well as aiding in the response to natural disasters, Peterken adds that the Federation is well placed to help susceptible regions prepare for any likely future events. "We are about to pre-position IT and telecoms emergency response kits around the world. We have identified the most at risk areas of the world in terms of disasters, and will target our communications stock for these regions. We know that if we have kit available we can get communications up and running." This programme is being funded by ECHO (European Commission Humanitarian Aid department).

Hugh Peterken
Head – Information Systems Department
International Federation of Red Cross and Red Crescent Societies

4: Hurricane Katrina

Hurricane Katrina was the first category 5 storm of the 2005 hurricane season, and made landfall (for a second time) on the central Gulf coast of the United States on 29 August 2005. It caused major damage to the coastal regions of Louisiana, Mississippi and Alabama, and in addition breached the levee system safeguarding the city of New Orleans from the waters of Lake Pontchartrain. The death toll passed 1,280, more than one million residents were displaced, and the estimated damage amounted to more than $200bn. This was one of the gravest natural disasters ever to affect the country.

There was extensive damage to the communications infrastructure of the affected states, hampering relief efforts as well as isolating the local population from information. Hurricane Katrina knocked out more than 3 million customer fixed-telephone lines and also inflicted damage on switching centres. More than 2,000 cell sites in the local wireless networks were out of action. In addition, about 100 broadcast stations were taken off the air and hundreds of thousands of cable customers lost service. According to the Federal Communications Commission, more than 20 million telephone calls did not go through the day after the hurricane.

By 29 September, one month on (and after the additional disruption caused by Hurricane Rita on 24 September) the FCC estimated that 2.5 million fixed lines had been restored, leaving 264,000 customers out of service. Only one wireless switching centre remained out of operation and over 1200 cell sites had been restored. Although 820 (mostly in New Orleans, with Biloxi next hardest hit) cell sites were still out of service,[11] nearly all of the affected area had cellular coverage thanks to the use of portable base stations and generators, aided by the rerouting of calls around trouble spots. [1] Ten television stations and 79 radio stations remained off-air one month on. (Radio is a source of emergency information with the key similarity to cell phones that radios operate on battery power and the key difference that the information is one-way.) Cable remained badly affected. Satellite communications were little affected throughout, and provided back-up to the emergency services via satellite phones.

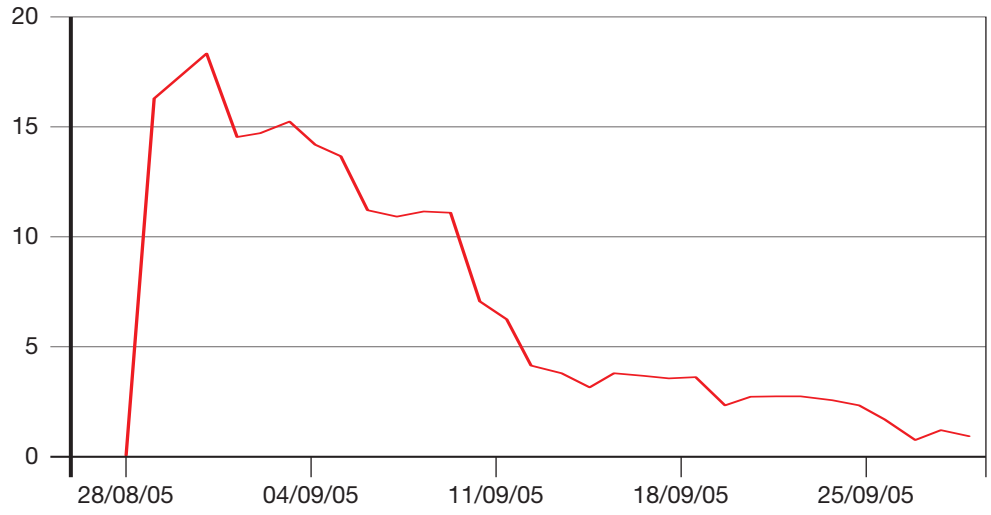
In summary, the FCC data collected from all the relevant providers suggests that after satellite, the mobile network and radio and TV broadcasts proved about equally resilient to physical damage, while fixed-line networks and cable were more severely affected. The data also show that, while mobile networks did sustain hurricane damage, the recovery of network coverage was rapid.

Response of wireless providers

The main obstacles to restoring wireless service were flooded facilities, power loss, diminishing fuel supplies for generators, and security. Wireline operators began to restore service within five days; wireless operators within just one or two days, with substantial improvement by the first weekend. Within only about 10 days of the hurricane, although a proportion of cells remained out of operation, the use of back-up equipment and rerouting of calls meant that almost all mobile customers were able to access their service as normal. Even within just a few days the great majority of customers were experiencing normal or near-normal service.

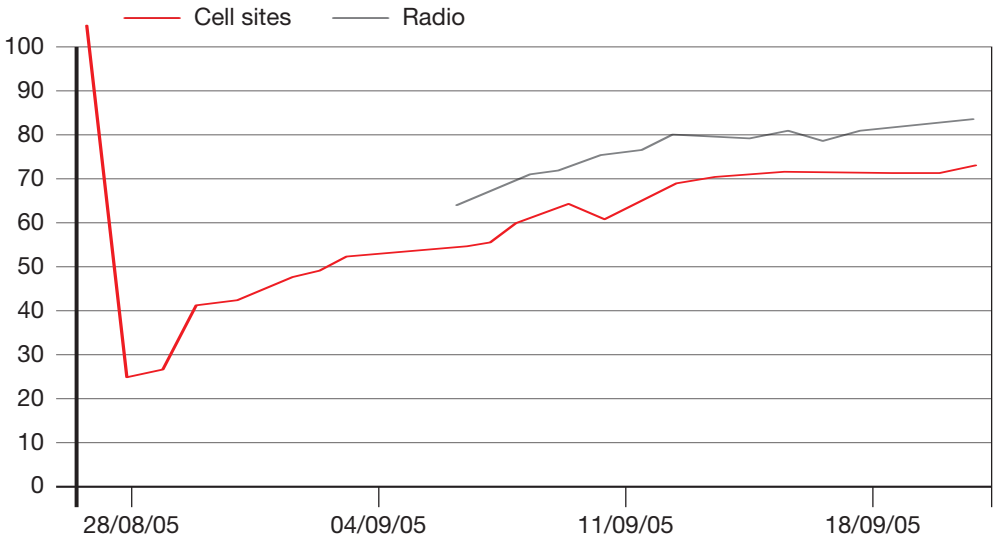
11 60% of the cell sites in New Orleans were operational as of 29/9/05.

Figure 7: Daily failed calls in the wake of Hurricane Katrina, millions



Source: FCC

Figure 8: Percentage of cell sites and radio stations operational



Source: FCC

All of the operators immediately put into operation their disaster plans, both in terms of repairs and restoring network coverage, and in terms of assistance to customers and humanitarian efforts. Restoring cell phone services involved a range of emergency equipment.

COWs are cells on wheels, self-contained mobile cells which can be towed into place. COLTs, or cells on light trucks, are smaller, including two masts for microwave antennae. RATs are remote antenna trailers, containing a back-up antenna for a damaged tower. These vehicles, along with generators and fuel supplies, were sent quickly from many locations outside Louisiana, Mississippi and Texas to provide emergency back-up. The operators also provided many free handsets, both to customers whose phones had been lost or damaged, but also to the emergency services and relief organisations. Technicians worked to carry out repairs, and install emergency generators. Operators sent trucks with banks of cell phones to allow residents to make free calls. They also provided relief supplies such as water, batteries and food, and were closely involved in fundraising efforts. Like so many other businesses in the affected areas, they put huge efforts into dealing with the aftermath of Katrina, with many individual employees showing tremendous dedication in a chaotic and difficult situation.

The lessons learned from Katrina, based on discussions with Cingular and T-Mobile USA, and the evaluation of the FCC, fall into three categories: network restoration; co-ordination between multiple organisations; and customer relations.

Network restoration

As the FCC data show, more than 70% of cells in the affected area were in operation 10 days after the hurricane struck, making normal service available to the vast majority of customers, and the responses from all operators seem to have been equally effective. The speed of service recovery may come as a surprise to anyone who recalls the dramatic scenes of the aftermath of the hurricane.

Cingular reported that its service throughout the region had been restored to 75% of normal capacity by 8 September. In many places service was fully restored at that point, but at that stage only 50% in New Orleans, which was hardest hit by storm damage and flooding. One switch in the city was completely under water, although the operator was quickly able to reroute calls. A week later Cingular's service in New Orleans itself was more than 70% restored. The company was using microwave and satellite connections to restore service to the city, and rerouting calls outside New Orleans. The effort involved more than 30 COWs and over 500 generators.

T-Mobile also was able to respond and restore service very quickly. There was 50% coverage in New Orleans on 2 September and near-normal coverage by 29 September. T-Mobile too was using dozens of COWs and hundreds of emergency generators. Although its coverage in downtown New Orleans was severely restricted, it did keep its network switch in the city maintained throughout the storm and the aftermath, and within a few days had repaired several sites in the city including a high capacity cell site operated by a generator on top of the Crowne Plaza hotel on Canal Street. Technicians had required National Guard escorts, however, and the effective response was also due to one courageous technician staying at the network switch location throughout the first week to keep it in operation. All GMS/GPRS cell phone users had roaming access to the network in the area, and T-Mobile also provided priority network access throughout the Gulf area to the police, National Guard and emergency services. The network logged 600,000 calls in and out of New Orleans on 29 August, 1.1 million the following day and 1.4 million on 31 August.

One of the lessons from the experience was the interdependence of all the forms of infrastructure and emergency response. Wireless operators rely on wireline operators to ensure switches remain operational, so network restoration needed to work around damage to fixed lines. Both relied on the highway network: many technicians and supplies were hindered by damage to the highways, and the cessation of regular UPS and FedEx deliveries, so alternatives had to be put in place.

Power outages were a problem for all other providers, and while generators were available, there were not enough for all cell sites, and fuel supplies became an issue in some areas. Restoring any single part of the infrastructure involved the functioning of the other parts too, and co-operation between many organisations.

The FCC took steps to ensure operators were able to do whatever was needed to restore service, waiving rules to allow traffic rerouting and issuing temporary frequency authorisations, for example. It also provided $211m from the Universal Service Fund for the restoration of services and provision of phones to certain groups of consumers. Kevin J Martin, Chairman of the Federal Communications Commission, announced at the end of September that an independent expert panel will look at ways to improve disaster preparedness and network reliability in future. He said all communications providers must ensure they had in place best practices to allow speedy network restoration, including sufficient emergency generators, fuel and equipment.[12]

Co-ordination between organisations

A common theme in all evaluations of the aftermath of a hurricane is the unexpected degree of chaos and the absence of prior co-ordination between the many agencies and individuals involved in relief efforts. Co-ordination was of course hampered by the loss of communications capacity itself. Operators had to engage with local, state and federal authorities and agencies, with public safety officials and the National Guard, with numerous relief and voluntary agencies from the American Red Cross to local church groups, not to mention their own employees, customers and other members of the public. While operators had disaster response plans in place and many had run drills to ensure they could deploy COWs and generators as needed, there appears to have been less prior planning for other aspects of the emergency. All were faced with multiple requests for information and for equipment, often from different parts of the same organisations. For example, requests for free phones came from individual Red Cross volunteers walking into retail outlets in addition to the central requests made to head office. Co-ordination of the information flows emerged only after the first few days.

One specific issue in the United States is the need for inter-operability of the communications systems of first response emergency services. In mid-2004 the Department of Homeland Security set in motion a programme to ensure there was crisis communications compatibility in America's major cities, and it is continuing to work towards inter-operability throughout the country. In the aftermath of Hurricane Katrina, the emergency services still lacked the means to communicate effectively with each other, according to some members of the technology subcommittee of the House Homeland Security Committee. Lacking inter-operable communications equipment, mobiles offer the emergency services an alternative means of communication, although the damage caused by the hurricane did limit their ability to make mobile calls short term. One of the questions explored in the subcommittee and later debated on the floor of the House was whether the FCC could have made available more additional spectrum than it did to the emergency services immediately after the hurricane.[13] The FCC has responded to the need to improve co-ordination by establishing a new Public Safety/Homeland Security Bureau to take responsibility for all FCC disaster management activities.

Wireless operators too will need to ensure a co-ordinated response in any comparable situation in future, ensuring that policies are known throughout the company in advance of the emergency. Operators concluded that there needs to be both a central point of contact for providing consistent information, and thorough dissemination of necessary information to all employees. As one said: "The more information you get to the people involved, the more empowered they are to respond in an effective and professional manner."Another pointed out that the people being asked to provide help and information during an emergency are those on the ground who are most overloaded

12 Written statement for the hearing on Public Safety Communications from 9/11 to Katrina, before the Subcommittee on Telecommunications and the Internet, Committee on Energy and Commerce, United States House of Representatives, 29 September 2005. All FCC materials are available at http://www.fcc.gov/cgb/katrina

13 Before the storm hit the FCC released 24MHz of spectrum in the 700MHz range and 50Mhz in the 3.5GHz range for data amplification.

with all kinds of demands, so pre-planned co-ordination is essential to ensure they are not diverted from genuine priorities.

Customer relations

It soon became apparent that customers, desperate to make contact with family members, friends and neighbours, urgently sought all kinds of information from operators in the aftermath of the hurricane. In the chaotic situation, simple functions like paying bills became logistically difficult. Many people also wanted to replace lost and damaged handsets. In addition to the technical and logistical issues involved in network restoration, operators also had to respond to the needs of their customers, which was in some ways more challenging. Operators had to adapt and communicate their policies very quickly.

Retail outlets were often the customers' first place of call, and those employees needed guidance on how to answer questions. With customers anxious about costs, or the risk of being disconnected, most operators offered reduced charges including some free calls and texts for some weeks after the hurricane. It soon became apparent that it was vital to clarify policies towards charging, arrears, bill collection, and lost handsets, and to ensure the policies were communicated to customers, whether they were in stores, seeking help in emergency shelters, or getting information from websites or calling helplines.

Operators all provided phones to relief agencies and shelters, and some free calls to all affected customers, as soon as they were able, in addition to contributing other supplies such as water and food. In addition many operators provided free wireless broadband to relief agencies trying to reconnect families, free wi-fi hotspots in key locations, and emergency communications centres throughout the affected regions offering free long distance calls. The aftermath of Katrina, when some families had been dispersed to different shelters, often far apart and chaotically organised to begin with, clearly illustrated the way that mobiles have become invaluable for reconnecting displaced people. The process is much faster compared with the traditional paper-based systems, and the emotional distress consequently greatly reduced.

Both the FCC and the operators also posted consumer advisories, telling customers to ensure their handset batteries are charged ahead of an emergency, to have a back-up battery, to keep their phones dry, and to expect the network to be busy in the aftermath of an event. One key message for customers in the United States is the usefulness of text messaging at times when voice calls may not be able to get through. This is mainly because SMS messages use much less bandwidth. Messages can also, if necessary, be queued and sent on as capacity is available. The ratio of text messages to voice calls is about 1.2:1 in the UK and as much as 10:1 in some Asian countries; but well below one for one in the US. According to a survey earlier in 2005 by the Pew Internet Project, only 27% of America's 134 million mobile phone users have ever sent a text message at all, although the volume of messages is increasing.[14]

Summary

There are several relevant lessons from the experience of Hurricane Katrina:

- The aftermath demonstrates once again the importance of decentralised communications for both emergency responders and the individuals affected by the disaster.
- All the different parts of the infrastructure are interconnected, which affected the restoration of mobile networks. Nevertheless, the speed of recovery was greater for mobile than for other forms of communication.
- For the operators, the technical challenges were obvious, but in addition they needed to implement disaster response policies and restore communications with customers as quickly as possible.

14 See http://www.pewinternet.org/press_release.asp?r=99 for further details.

5: Floods in Central Europe, August 2005

The summer of 2005 saw large parts of central Europe inundated by floods. Heavy rainfalls led to serious floods and mudflows in the south and west of Austria during the last days of August. Many road connections were cut off, train connections were seriously disrupted, and phone and mobile phone lines were disconnected. In Bavaria, some flood defences collapsed, allowing water to surge through streets and into homes. Southern Germany experienced more than 150 litres of water per square meter within 48 hours and a state of emergency was announced in the districts of Garmisch-Partenkirchen, Oberallgäu, Bad Tolz, Miesbach and in the towns of Kempten (Allgäu) and Augsburg. A large motorway bridge near Augsburg had to be closed due to the danger of collapse. Some cities were cut off for some time. In Switzerland parts of the country were cut off for up to five days. Flooding caused landslides and even tremors. Alpine towns in Switzerland were evacuated, with hundreds taken to safety in Brienz. The Swiss capital Bern was also hard hit by the flood water. At least 11 people were reported dead or missing in Switzerland, Austria and Germany.

The death toll was higher still further east. In Croatia the authorities declared a state of emergency in two regions hardest hit by the floods. Dozens of homes on the banks of the Mura were evacuated. Romania was one of the countries worst affected, with a death toll of 31. Around 2,000 people had to leave their homes. This was the latest in a series of six consecutive floods since April. There were also reports of people missing. Altogether 20,000 homes were flooded and 1,000 bridges were damaged. Hundreds of communities have been affected and large-scale evacuations have taken place. Power cuts were widespread and safe drinking water supplies were limited. Heavy rains in April and melting snow from the Carpathian Mountains caused the river Tamis on the Romanian/Serbian border to rise rapidly. On 20 April flood waters spilled over river banks flooding Jasa Tomic in Serbia. There was damage to infrastructure, housing and agricultural land in Macedonia. In Bulgaria during the three summer months, bad weather affected 2 million people, killed 20 and made 20,000 homeless. Huge amounts of farmland and infrastructure (including railways) were damaged or destroyed, and 27 municipalities were affected. More than 70 destroyed or damaged bridges were reported. Water supply systems were disrupted and 28 dikes and dams were damaged.

This section looks at the role of mobiles in two of the affected countries, using network information provided by Vodafone Germany and by Swisscom.

Response of mobile providers

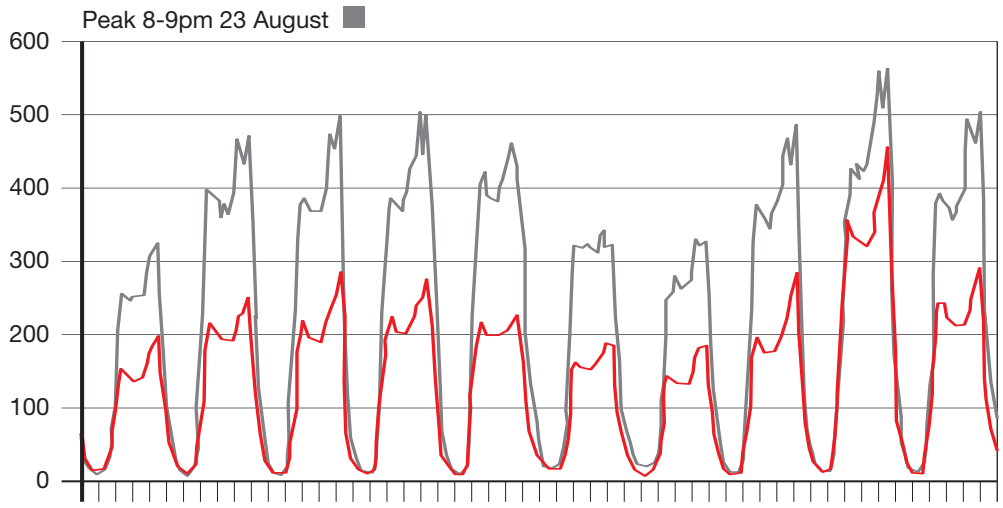
In southern Germany the peak flooding occurred on 23 August 2005. Network damage was relatively minor. Six cells to the west and south of Munich were taken out of action by the floods: two lost power supply, one of these because a bridge carrying the cables was washed away; in the other four cases leased lines to the cells were damaged by water or landslide. Traffic volumes on the network increased substantially, with an overall increase of about 21% compared to normal.[15] However, at the peak, mid-evening on 23 August, the two busiest cells saw a 275% increase in voice usage and a 350% increase in SMS volumes.

The increases were nevertheless well within the range of increases normal at other times when people want to make calls, such as sporting events or New Year. For example, there was a bigger peak during the opening match of the season at Bayern Munich. There was some congestion on the network but even at its maximum this was less than when compared to other events such as sporting fixtures. Vodafone Germany was able to make intense usage of data compression to permit the busiest cells to support twice the normal number of connections ("half rate"), although with some inevitable loss of quality. The chart below shows the number of calls for two of the busiest base station controller areas[16] in the flooded districts south of Munich, by the hour, from 15 to 24 August.

15 Volumes are measured in erlangs, units named after Danish telephone engineer A.K.Erlang. One resource such as a single line in continuous use implies one erlang of traffic. See http://en.wikipedia.org/wiki/Erlang_Telecommunications_Unit

16 A base station controller controls a set of cells and their radio connections.

Figure 9: Hourly call volumes (erlangs) 15-24 August 2005

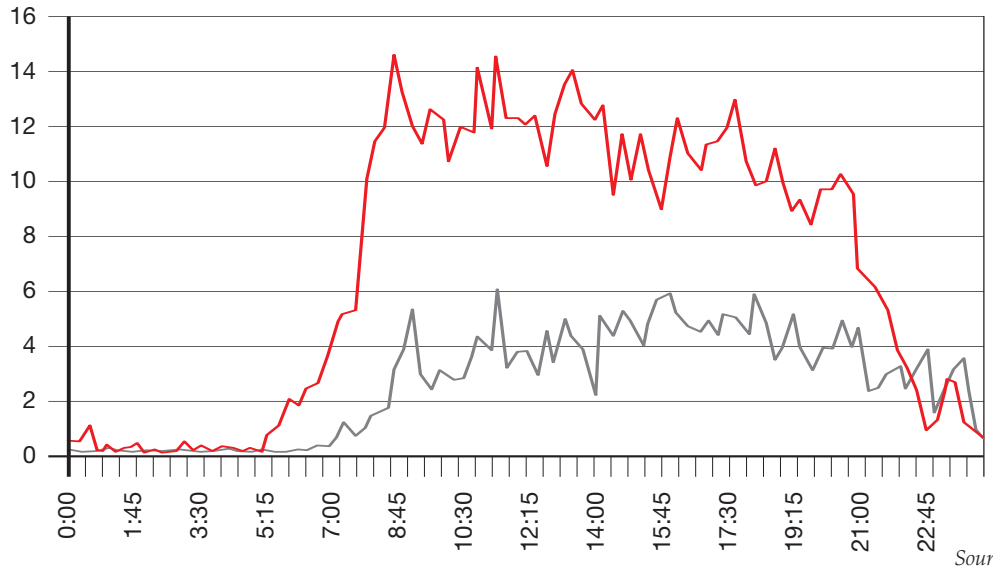


Source: Vodafone

In Switzerland the physical damage caused by extensive flooding which peaked on 22 August 2005 was more severe, and large areas of the country were affected. By 26 August, repairs to the severe damage caused to Swisscom's mobile and fixed networks by the floods were already under way and the mobile network coverage was back to comprehensive. Transmission paths were up and running in all the affected areas, thanks to backups in the cable network and the use of directional radio. Capacity was limited in some places, however, and a total of 5,300 telephone and 7,000 broadband connections were still disconnected from the fixed network due to flooding of the cable and exchange infrastructure, hardware defects and power cuts. Flooding of cables and exchanges and loss of power were the main physical problems. For example, a number of fixed-line exchanges were under water for several days.

There was a significant rise in traffic on the Swisscom mobile network throughout the affected region on 22 August. The volume of traffic at the busiest time of day in the affected group of cells was 50% higher than the same day a week earlier. The chart below shows the volume of traffic for just one Swisscom cell in Bern, by the hour, for the day of the flood (22 August), and the same day the previous week for comparison. The floods more than doubled the volume (measured again in erlangs); the volume was three times normal at the busiest time of the day. The displayed cell had to take over traffic from another nearby cell which went out of operation at 8am when the building and base station were flooded.

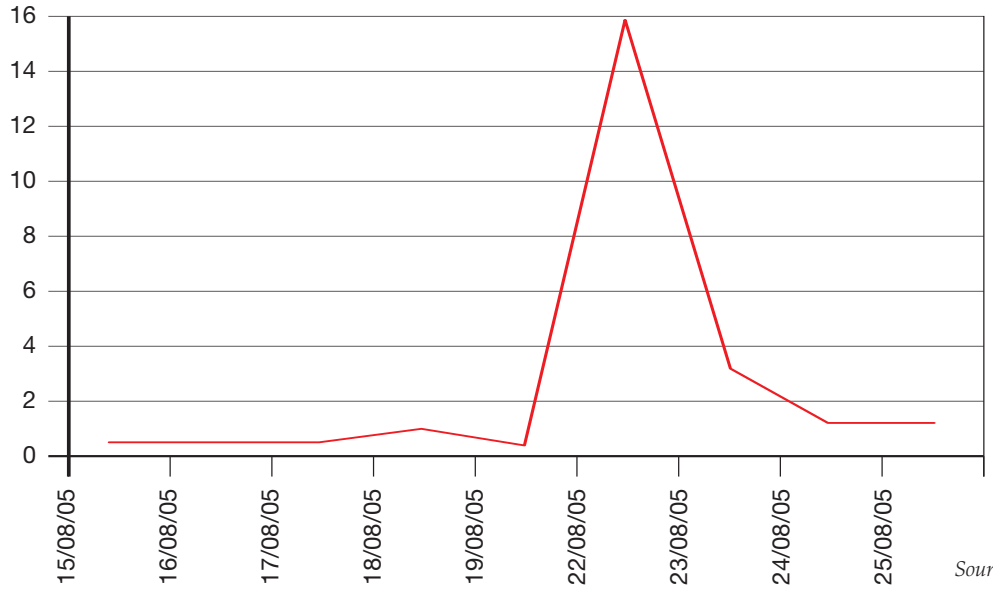
Figure 10: Call volume, single cell, 22 August compared with a week earlier



Source: Swisscom

There was a resulting increase in congestion in the same cell: the number of successful connections surged, but there was an even bigger peak in the number of failed handovers. The ratio of failures to successes on 22 August was six to one, although it had fallen to just over two to one the following day. The congestion problem did not completely ease until 25 August, when the flooded cell was restored. This was not an isolated problem. As the figure below shows, all of Bern was affected.

Figure 11: Congestion time, Bern, in seconds



Source: Swisscom

Data for all 71 cells covering Bern also show a big increase in data traffic as well as voice calls. The volume of data traffic climbed from 45 mbytes a day during the previous week to 66 mbytes on the day of the floods, and remained at an elevated level for some days.

Summary

- The experience of the floods shows that there will be congestion on the mobile network, but it is not necessarily more extreme than at other times of high demand locally, such as sporting events.

- As emergencies can never be exactly anticipated, the key to an effective response lies in the operators' having an effective process for managing congestion in the hours immediately after the disaster strikes. This will include prioritisation of calls made by and to the emergency services, and the management of other demands.

6: Terror Attacks

The aftermath of a terrorist attack has some key similarities to natural disasters, and many differences, above all the security concerns. Our aim here is to consider the common issues by looking at the network impact of one specific attack: the blasts in Istanbul on 17 November 2003 (6.1:), and to set out the issues raised concerning the impact of mobiles after a number of recent terrorist incidents. Specific security issues go beyond the scope of this report, however.

Managing the surge in demand

The first major similarity is that, just as in the case of natural disasters, mobile phone networks experience a surge in demand in the immediate aftermath of a terrorist attack. Some calls are made by and to the emergency services. Some calls may involve sharing information about what is happening; many will be to check on people's safety. There is a vast amount of evidence from newspaper reports and analyses of several attacks on the use of mobiles to transmit information, including contacting the emergency services, calling or texting family and friends to reassure them, informing the broadcast media of events as they unfold, and also gathering information from elsewhere to gain a better awareness of what is happening. 6.1: discusses mobile providers' needs to manage the heavy demands.

Decentralised sharing of information

The second similarity between the role of mobile in the case of natural disasters and terrorist attacks is the decentralised sharing of information which can save lives, particularly when official sources of information are sparse.

One particularly powerful example of the benefits of informal, person-to-person communication significantly enabled by mobiles is provided by the 9/11 attacks on the World Trade Center (WTC). According to the National Institute for Science and Technology (NIST), 16% of the survivors from each tower had made phone calls (fixed line and cell phone) to others outside before making their decision to evacuate the building; and devices such as cell phones and Blackberries were the only way survivors from WTC1 learnt about the second plane. These callers passed on their information to colleagues, and the survivors surveyed by NIST had overwhelmingly initiated their own evacuation after receiving such information, according to the report. Official radio communications channels were experiencing problems, the emergency command and control capability had been destroyed, and official warnings over the public address system were contradictory. As a result of its analysis, the report urges the use of local systems of emergency information sharing via registered mobile devices such as cell phones and PDAs.[17]

Other issues - Several other aspects of the impact of mobiles in the context of terrorism have been raised in recent debate. We list them here for completeness but do not attempt to analyse the complex policy issues they raise.

Public's use of camera phones - This was one of the most striking phenomena of coverage of the 7 July bombs on the London transport system. It was the first event involving large numbers of people carrying camera phones. People caught up in the blasts emailed pictures to TV stations, with a speed and in numbers which made them the most dramatic images of the blasts. Mobile video footage provided by eye-witnesses was aired on TV within half an hour of the explosions. The BBC received more than 300 emails containing 900 still images on the day of the attacks, 50 within an hour, as well as 22,000 text messages describing what was happening.[18] The phenomenon has changed news gathering, but raises issues about authenticity and privacy.

17 Final report of the National Construction Safety Team on the Collapses of the World Trade Center Towers, draft published June 2005, especially chapters 7 and 8. http://www.wtc/nist.gov, accessed 20 October 2005.
18 http://news.bbc.co.uk/go/pr/fr/-/1/hi/uk/4745767.stm, accessed 4 August 2005.

Forensic use of mobiles - The Metropolitan Police in London requested that members of the public send in all the images they had taken in the aftermath of the London attacks, as part of their evidence-gathering process. UK police and Italian police also used mobile calls to track Hussain Osman, a suspect in the failed 21 July London attacks, leading to his arrest in Rome. This is one aspect of the growing forensic use of mobile records by the police. The EU has under way a project to ensure that electronic evidence is gathered and stored legally.[19]

Use of mobiles as a new means of triggering bombs - This issue has been quite widely debated in public although this use of mobiles has been officially acknowledged in only a few cases such as the Madrid train bombs in March 2004. Very few public authorities have felt the need to respond, not least because they recognise that this is only one means of detonating an explosion. Amongst the most prominent examples of a response, New York authorities halted phone services in two Manhattan tunnels for four days after the 7 July bombs in London. Service in two other tunnels linking Manhattan to New Jersey remained switched off. Los Angeles authorities considered the use of cell phone jamming equipment at Los Angeles International Airport but did not introduce it.

Storage of data-tracking calls and messages - In the wake of the Madrid bombs, the European Council proposed new data-retention legislation for telecommunications operators and internet service providers. Pressure for EU-wide legislation increased following the London bombs on 7 July 2005. The latest European Commission proposal on data retention covers the scope of data to be retained, the period of retention and compensation for the industry; it is currently under discussion. The amount of data to be stored would be voluminous, by comparison with the present commercial retention of data. Many commentators have also noted the privacy concerns raised by the proposal. A full evaluation of thecosts and benefits of additional data-retention requirements should be made before new policies are introduced.

Anonymity of pre-pay mobiles - Several countries, from Switzerland to Malaysia, have begun to require users of pre-pay mobiles to present proof of identity and register their details with the operators, to tackle crime in general as well as security.[20] The proportion of pre-pay customers in the total averages 40% for OECD countries and is higher in developing countries. These proportions are increasing. Identity and registration schemes may not be either necessary or effective, however. Pre-pay users can be identified through their call patterns and those of their correspondents. Furthermore, pre-pay phones can be transferred between users, and criminals or terrorists are likely to adopt a fraudulent identity anyway. The ethical and privacy concerns raised by registration schemes could therefore outweigh their supposed security benefits. For these reasons, a number of other countries have considered and rejected pre-paid registration schemes.[21]

19 See report in Jane's Police Review, "Forensic Telecoms Revolution is Turning Mobile Phones Against Their Criminal Owners". Posted http://pr.janes.com 29 September 2004. See Gordon A Gow, "Survey of Prepaid Mobile Phone Regulation and Registration Policies among OECD Member States." Research Report for the Office of the Privacy Commissioner of Canada. Centre for Policy Research on Science and Technology, Simon Fraser University at Harbour Centre, Vancouver Canada, forthcoming 2005. Project website: http://www.sfu.ca/cprost/prepaid/

20 See Gordon A Gow, "Survey of Prepaid Mobile Phone Regulation and Registration Policies among OECD Member States." Research Report for the Office of the Privacy Commissioner of Canada. Centre for Policy Research on Science and Technology, Simon Fraser University at Harbour Centre, Vancouver Canada, forthcoming 2005. Project website: http://www.sfu.ca/cprost/prepaid/

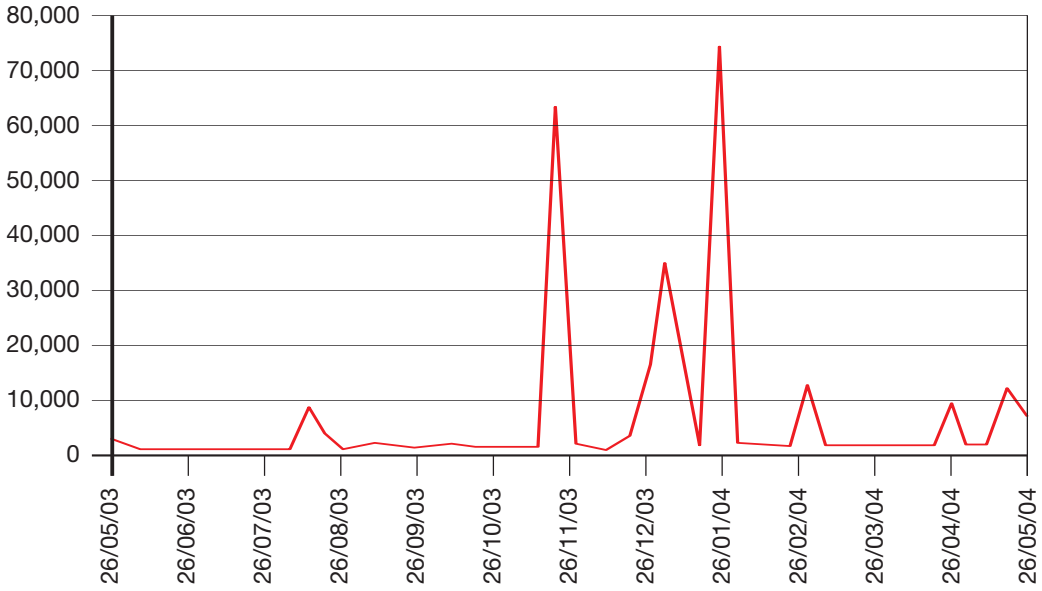
21 See Gordon A Gow, 'Prepaid Mobile Phones: The Anonyimity Question', Discussion Paper, Department of Media and Communications, London School of Economics, September 2005. Can be downloaded from http://www.oii.ox.ac.uk/research/cybersafety/?view=papers

6.1: Network Impact of a Terror Attack: Istanbul, 20 November 2003

Just before 11am on 20 November 2003 separate blasts hit the British consulate in Beyoglu and the 12-storey headquarters of HSBC, in the Levent district of Istanbul. The British consul-general was amongst the 27 people killed that day, and more than 450 were injured in the attacks. Five days earlier, two synagogues in the city had been bombed. The death toll for the week was 60.

According to data from Turkcell, Turkey's largest GSM operator, there were peaks in outgoing call attempts, conversations and SMS messages sent. As the chart below shows, the pattern of peak demand is evident in the data on call congestion (which measures congestion at defined switches on outgoing routes, although some of the calls may have been connected via other routes).

Figure 12: Congestion, outgoing calls, Levent, Istanbul, May 2003 to May 2004



Source: Turkcell

The issues are not unique to the blasts in Istanbul, of course. Immediately after the 7 July London bombs, all the mobile networks were congested, making it hard for callers to get through on the first attempt. In this case, the increase in volumes was extremely large, with some network operators reporting that call attempts and SMS volumes had more than doubled compared to normal. For example, there was a three-fold increase in traffic on the Vodafone network on 7 July. The number of call attempts to the network increased more than tenfold. Call duration was also significantly longer than normal.

Naturally, after every terrorist incident, wherever it occurs, there is a surge in the number of calls people want to make, either to learn what is happening, to contact their workplace, or to reassure family and friends, putting network capacity under strain. At the same time as the surge in demand, the needs of the emergency services increase greatly as well, and frequently extra capacity will have to be allocated to them. This is all the more important in contexts where the emergency services' own dedicated radio equipment does not function well, or is overloaded.

The need for operators to manage competing demands in situations of network congestion is not unique to mobiles. It is a familiar problem in many contexts where there are peaks in demand. The economically efficient solution, variable pricing to spread the demand (such as the "yield management" practised by airlines) obviously cannot be applied in this case.

In the case of the mobile network, the first crucial step that operators must take is to prioritise its use by the emergency services. Beyond that, the challenge is to manage the short-term demands made on the system so that the network does not crash. Calls can be rerouted. In addition, the use of standard load-management techniques such as queuing or taking some users off the network for a short time, will be necessary.

A key element in managing demand is for customers to send text messages rather than make voice calls. Texts use less bandwidth and can easily be queued. This is an important message to convey to the public. Phone users in the UK send more text messages than they make voice calls anyway (the ratio of text to voice is more than one to one), and many now know it is easier to send a text than make a call when the network is busy. Text use is not so widespread in other countries.

If network congestion is sustained for more than a short period, operators can take additional steps such as the use of "half rate" quality adjustments. However, this does require technical adjustment of the transceivers at cell sites; so to does the use of additional spectrum, if allocated, to modify the system to use additional frequencies.

Some commentators have urged governments to consider making more spectrum permanently available to the emergency services so mobile operators do not face conflicting demands on their networks, and a number of governments are already doing so.[22] However, the period of congestion is relatively short, usually being confined to the impact period of an event. During this period all forms of communication come under strain. What distinguishes mobile from other communications technologies is its potential for extremely rapid recovery of the network and therefore its contribution in later phases.

22 See for example "Harness the Power of Mobile Phones" by Kenneth Neil Cukier, International Herald Tribune, 4 August 2005.

7: Conclusions

The examples described in this report show the importance and value of mobile communications in the aftermath of disasters. This value is enhanced by two trends. One is the extraordinarily rapid spread of mobiles in developing countries, some of which are very vulnerable to natural disasters, and many of which are badly affected when disaster does strike, because of their infrastructure and emergency response capabilities are often weak. The other trend setting the context for the role of mobile is the increasing number of disasters, demonstrated so dreadfully many times in the past 12 months.

A careful study of the impact of mobiles makes it clear that the nature of communications needs differs at different phases of disasters: early warning, disaster impact, immediate aftermath and recovery. Each of these stages is best served by a different set of methods of communication, and in each of them mobile is of course joining an existing menu of information channels. Mobiles are therefore serving different needs in each case, which is one of the important lessons to be learnt from the examples given here. The distinctive contribution of mobile lies in its unique capacity to disseminate information quickly and informally from individual to individual, which has greater value during some phases of a disaster rather than others.

Some pilot *early warning* schemes based on mobile technologies are currently being tested, as described in this report. But mobiles are unlikely to play a central or solo role in the dissemination of information by the relevant authorities, and the emphasis some policy-makers are putting on mobile early warning is misplaced. In many countries, as the annual World Disasters Report from the International Federation of Red Cross and Red Crescent Societies makes clear, there are effective warning systems in place which do not depend on high technology at all: for example, hurricane warnings in the Caribbean disseminate meteorological warnings via radio broadcasts, but more importantly by drills taught each year in schools, so that people understand the warnings they are given, and by community-based teams who watch out for local flooding and travel from street to street shouting warnings by megaphone. Improving the effectiveness of early warnings is unlikely to ride on one single technology or communications channel, but rather will involve a mixture of prior surveillance, public education, disaster-preparedness, and a range of communications technologies including the broadcast media and the internet as well as mobiles.

On the *impact of a disaster,* in the chaotic hours that follow, emergency service communications will always be the top priority. In addition, the human value of mobile phones lies in people's desire to contact their family and friends as soon as possible. Together, these needs explain the peaks in call and text volumes and call congestion after disaster strikes. At the same time, all parts of the infrastructure, including mobile phone masts and switches as well as fixed lines, broadcast stations, electricity cables, roads and bridges, are vulnerable to damage. Operators can and do take steps to prioritise emergency calls and manage the high volumes of attempted calls, in circumstances where they are also trying to assess damage and make repairs as quickly as possible. Members of the public need to be aware that they are more likely to be able to make contact through SMS messages rather than voice calls.

In the *immediate aftermath* of a disaster, it is vital for operators and governments to work together to restore mobile networks as quickly and effectively as possible. Mobile networks, like other important parts of the essential infrastructure, are vulnerable to being damaged, and will inescapably face very heavy demands in the immediate aftermath of a disaster, as documented here. But they are capable of much faster recovery than other means of communication. It is in the aftermath, too, that the distinctive capacity of mobiles to disperse information to where it is most needed comes into play, especially as many people will be displaced from their homes. Emergency response teams from the mobile industry play an important role in either installing a temporary network for as long as needed, or restoring the mobile network extremely quickly. Mobile operators all have emergency plans in place, including measures such as reducing call quality to accommodate higher call volumes as well as planning for repairs and emergency generators.

It may also be possible for the public authorities to enhance the capacity of the network to accommodate increased demand after an emergency by providing additional spectrum. This is one of the policy issues being debated in the United States, post-Katrina.

In the *recovery phase* mobiles also make a completely distinctive contribution. In the case of developing countries in particular, mobiles are likely to be the dominant means of communication for affected members of the public. This flow of information – not mediated by broadcasting agencies or public authorities – ensures that people elsewhere quickly come to know what is happening and what help is needed. In the chaotic aftermath of a disaster, when people are displaced, buildings and infrastructure destroyed, no central authority can possibly hold all the necessary information and allocate resources to the place of greatest need. Indeed, as the 2005 World Disasters Report firmly pointed out, there can be real drawbacks in outside agencies trying to set themselves up as repositories of information.

To sum up, the importance of mobiles in both immediate aftermath and recovery phases lies in:

- the speed of network recovery;
- the inter-operability of mobile communications;
- the decentralised, person-to-person flow of information; and
- the accessibility of mobiles (especially when people are displaced from home).

Informal person-to-person communications by mobile have also played an important part in triggering fundraising and relief efforts amongst diaspora communities, such as Gujaratis living abroad after the 2001 earthquake there, or Pakistanis from the north western regions after the October 2005 earthquake. In addition, fundraising campaigns have been able to tap in to donations from people who respond to the immediacy of their emotions by calling or texting money. This does not seem to have reduced donations by other means such as posting a cheque. Private donations have increased in size relative to funds from official sources, and furthermore are more reliable, as official pledges are often not paid in full. However, one obstacle to enhancing the role of mobiles in fundraising for relief efforts is the need to put the tax treatment of contributions made by mobile, especially text messages, on the same basis as other charitable contributions. At present in many countries donations by mobile are at a tax disadvantage compared to other types of donation.

Mobiles may offer the first operational communications channel to the outside world, and certainly the first channel for communities and individuals to convey information about their specific needs, and to co-ordinate amongst themselves and with others who can help them. It is difficult to overstate the importance of access to mobiles in developing regions affected by natural disasters, an importance demonstrated by the examples given in this report. These case studies emphasise the importance of increased mobile penetration in developing countries. While access to mobiles has grown by leaps and bounds in many low- and middle-income countries, there are still many where mobile penetration remains very low. Extending mobile access in regions which are vulnerable to natural disasters and still have low mobile penetration would greatly help their ability to recover should disaster strike.

Natural disasters and other emergencies such as terrorist attacks bring in their wake chaotic, complicated situations in which people are frightened and uncertain. Accurate information is important at every stage, from early warnings to coping with the immediate aftermath, through to relief and recovery.

Mobile phones can play a part in early warnings and the immediate aftermath, like other means of communication. However, mobiles make their distinctive and therefore most valuable contribution in relief and recovery. One reason is the speed with which mobile networks can recover, relative to other forms of communication. The other is the unique capacity of mobiles to decentralise the sharing of information and improve the process of getting the right resources to the people and places where they are most needed after a disaster.

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