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The 2004 Thailand tsunami and the April 2012 tsunami warning were lessons learned?

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Abstract

This chapter reviews the events leading up to and immediately following the December 2004 tsunami that occurred in Southeast Asia; and the lessons that were learned from a logistical perspective are highlighted. It is clear that countries in the region lacked the communication infrastructure and logistics capacity and capability to deal with the aftermath of such an event. In the context of the 2004 tsunami, the effectiveness and speed of response, the significance of the cost element and the fragility of emergency supply chains in extreme conditions are highlighted. The tsunami raised many issues relating to large-scale humanitarian disasters, including the level of preparedness for such events and how best to manage logistics and supply chain activities in volatile conditions such as those immediately following the tsunami strikes. The discussion then summarizes, by means of a first-hand account, the response to a fresh, real-time tsunami warning issued by the Thai government.

On 11 April 2012 an earthquake magnitude 8.6 and a second earthquake magnitude 8.2 struck just two hours apart with epicentres approximately 500 km off Sumatra. They were in almost the same location as the 2004 earthquake that had devastated Banda Aceh. The direct involvement of two of the authors in the local response provided a unique opportunity to study events at first hand, and in this context the 'human logistics' of the event are reviewed. It is shown that, with current warning systems, evacuation mechanisms and chains of responsibility at a local level, large numbers of people can be moved quickly to safe zones. However, several systematic weaknesses are also shown to be both important and potentially critical: evacuation route signage is inconsistent, particular mobility needs at an individual level are not catered for, leadership in crisis conditions is weaker than required, and better filtering of information to establish fact from rumour during the emergency warning period is needed. There is, therefore, still substantial room for improvement, at a local level, in Thailand's overall tsunami response system.

Introduction

The purpose of this chapter is first to review the events leading up to and immediately following the tsunami disaster that occurred in December 2004 in Southeast Asia, and to highlight the lessons which were learned from a logistic perspective. The event made it tragically clear that the countries in the region completely lacked the communication infrastructure to provide the knowledge, capacity and capability to deal with the aftermath of such an event. Second, the chapter draws together the key aspects of a recent real-time tsunami warning sounded on 11 April 2012, which was unexpectedly experienced at first hand by AB and SB, two of the authors of this chapter. Although it has been widely acknowledged that logistics in all its forms is a critically important aspect of the response to large-scale emergencies and disasters, and the 2004 tsunami strikes confirmed this, the April 2012 emergency was different. It tested the information systems to their limits and beyond in terms of speed and accuracy of information dissemination and response management methods on the ground.

The severing of physical links such as roads and railways is made much worse if communication mechanisms are also fractured, or if the area affected is so large that communities are unable to link their experiences to one common cause, for hours or even days. Coordination of the relief effort in these circumstances thus becomes almost impossible (see, for example, Brown, 1979; Long and Wood, 1995; Kovács and Spens, 2007; Tatham and Pettit, 2010).

The 2004 tsunami highlighted many of these issues; consequently many organizations, especially in Thailand, began to give more attention to the balance between planning for, and responding to, large-scale emergencies. In taking a broad view of logistics it is clear that established logistics concepts can be extended further to include the movement of people at a local level. During the minutes following the 2012 tsunami warning, 'human logistics' (ie getting people to safe locations as quickly as possible) were arguably even more important than materiel supply chain operations subsequent to an actual tsunami hit. The later part of this chapter examines the range of responses observed and response mechanisms during a real-time tsunami warning (Banomyong *et al*, 2011).

What happened on 26 December 2004?

The waves severely affected the coastal fringe of most of the countries fronting the Indian Ocean including those in East Africa, the west Indonesian Archipelago and the Malaysian peninsula. Indonesia suffered most with more than 130,000 confirmed deaths (USGS, 2006) and almost total destruction of Banda Aceh and other coastal communities. In Thailand, according to Chanditthawong (2005), the tsunami was considered to be the most serious natural disaster the country has ever experienced. Table 7.1 shows the extent and scale of the disaster as gauged by the number of casualties listed by country.

The wave inflicted enormous damage on the southern Thai provinces along the Andaman Sea coastline. Phang-Nga was the province that suffered the most damage. In these locations the tsunami waves were responsible for at least 5,395 deaths, over 8,000 people were injured and more than 2,200 people were unaccounted for. The financial costs associated with the tsunami were estimated at over US $500 million in Thailand alone, and this figure does not include the loss of private dwellings (Rangsit University, 2005; BBC, 2005a).

The tsunami waves that hit the south west coast of Thailand destroyed villages, roads and large swathes of urban coastal development. Specific problems included: communication systems failures due to the destruction of the telecommunication network; mass structural damage; large volumes of accumulated debris; very limited road access; and extensive flooding. This resulted in a situation where the delivery of basic humanitarian aid was often out of balance with requirements. In the immediate aftermath of the tsunami aid was scarce, but as the crisis continued the lack of coordination meant that there was often oversupply of certain items, or supply of items inappropriate to conditions on the ground (Pettit and Beresford, 2005; BBC, 2005b).

Further, local officials and relief volunteers were either poorly trained or ill-equipped to cope with a disaster on such a scale. There was also little inter-agency cooperation stemming from the fact that individual agencies were not fully aware of how their own role fitted into the complex nature

TABLE 7.1 The Asian tsunami, December 2004: casualties by country

Country	Deaths		Injured
	Confirmed	Estimated	
Indonesia	130,736	167,736	N/A
Sri Lanka	35,322	35,322	21,411
India	12,405	18,045	N/A
Thailand	5,395	8,212	8,457
Somalia	78	289	N/A
Myanmar (Burma)	61	400–600	45
Maldives	82	108	N/A
Malaysia	68	75	299
Tanzania	10	13	N/A
Seychelles	3	3	57
Bangladesh	2	2	N/A
South Africa	2	2	N/A
Yemen	2	2	N/A
Kenya	1	1	2
Total	**~184,167**	**~230,210**	**~125,000**

Adapted from USGS (2006)

of the relief operation or how their actions could affect other agencies. Thus agencies 'competed' against each other leading to territorial rivalry and 'turf' issues (Salam, 2006). The chaos that followed the tsunami led to numerous questions being asked, perhaps the most important of which was that, if such an event were to occur again, how could the Thai authorities better

respond with their new warning and response systems so that the impact of a similar catastrophic event could be minimized? (DPM, 2005a).

Immediately following the tsunami, aid provision across the region had to be coordinated on an unprecedented scale among a number of governments and a wide range of non-government organizations (NGOs), United Nations (UN) bodies, the International Committee of the Red Cross (ICRC) and the military. The scale of the disaster was so large that in the early stages of the crisis it was only possible to get aid to a few of the worst affected areas with the use of military resources. In Thailand, however, the government, perhaps unaware of the true scale (and of the number of international victims) of the disaster, initially stated that they did not wish to receive help from external sources.

In the region around Banda Aceh, in contrast, it was reported that around 400 separate organizations were working, providing a broad range of humanitarian assistance after the tsunami. The Indonesian government worked very closely with implementing partners and, as the situation on the ground began to stabilize, only those organizations that were deemed to be performing effectively were permitted to stay. Such organizations included UN relief agencies, NGOs, government agencies, the military (both international and national) and private companies – hindering all of them was the common problem of a lack of preparedness. Serious secondary problems included the widely diverging needs from region to region and the mismatch between requirements and goods supplied. The main need in Sri Lanka, India, Thailand, the Maldives and Malaysia was generally for clean water, food and medical supplies. But, the initial surge of donations in Thailand was winter clothing donated by garment export firms, which was inappropriate for the location. Overall, the amount of unsolicited and inappropriate aid presented a logistic problem in its own right in all the countries affected (Beresford and Pettit, 2007).

Hazard event response in Thailand

The Department of Disaster Prevention and Mitigation at the Ministry of Interior (DDPMMI)

There was no question that the Thai government was completely unprepared for the effects of the tsunami. The underlying reason was the general belief that a tsunami would never occur in Thailand, while other major forms of environmental disaster, eg floods, windstorms and mudslides, have regularly affected the country, especially in specific seasons. It was therefore logical to have response plans for such events, and these generally existed. However such plans did not relate to tsunami events. The DDPMMI undertook a survey in 2004, ironically just prior to the tsunami and ascertained that the key organizations involved in disaster planning should have

integrated short- and long-term impact mitigation plans. It was proposed that disaster warning systems should be installed, with the entire data system linked together. Additionally, there should also be detailed mapping of both disaster-prone areas and evacuation areas. Several specific problems were identified, mostly relating to central organizational structures and associations. These included lack of experience in large-scale disaster management, duplicated work among agencies, inadequate data handling capability, and unclear communication and decision-making systems. At a more local level problems included telecommunication inadequacies including cell-phone network coverage, shortage of rescue equipment and disaster warning systems not covering all areas. Although there was theoretically a clear structure for disaster response, in these reports there was a complete absence of reference to the tsunami hazard and, by implication, there was thus a complete lack of preparedness for a tsunami-type event (DPM, 2005b).

Tsunami warning and evacuation

Following the December 2004 tsunami, there was a clear need to revisit disaster planning with regard to this type of event. A major review of preparation plans, evacuation procedures and contingency measures was therefore conducted. A Master Plan for Tsunami Evacuation (DPM, 2005a) was developed, falling within the remit of two government Acts (the Civil Defense Act and the Building Control Act) and two government Plans (the Civil Defense Plan and the National Preparedness Plan). The areas which that identified as being vulnerable to the tsunami hazard were mainland Thailand fronting the Andaman Sea, and all islands and island groups in the six southern provinces of Ranong, Phang-Na, Phuket, Krabi, Trang and Satun. The vulnerable areas are split into sub-districts and villages as shown in Table 7.2.

The Master Plan tasks the Regional Civil Defence Directing Center (RCDDC) to direct, control, administer and provide recommendations about tsunami prevention and mitigation. The emphasis in this document is primarily on evacuation, communications and victim support, and reference to the distribution of aid materials to disaster victims mainly focuses on supplies, temporary shelter and health/welfare materials. Thus within its remit, transport and logistic support are implicit rather than explicit.

Consistent with other approaches, for example that of Carter (1999), the Master Plan for Tsunami Evacuation highlights three main phases: pre-disaster, during disaster and post-disaster. The pre-disaster phase identified all communities at risk where the main effort is placed on heightening individuals' awareness of the procedures needed to be adopted in the event of a tsunami strike. Specifically, the preparations involve: identifying safe areas for evacuation, signposting of main and alternative evacuation routes, posting of maps showing these routes, formation of emergency support units and the provision of vehicles, tools and obstruction clearance equipment. Several models have demonstrated that 15 metres above sea level is generally

TABLE 7.2 Tsunami susceptible areas in Thailand

Province	Total	Sub-districts	Villages
Ranong	2 Districts 1 Branch District	10	47
Phang-Na	6 Districts	19	69
Phuket	3 Districts	14	63
Krabi	5 Districts	22	112
Trang	3 Districts 1 Branch District	13	51
Satun	4 Districts	17	70
6 Provinces	**23 Districts** **2 Branch Districts**	**95**	**412**

SOURCE DPM, 2005a

safe and 20 metres above is safe in virtually every tsunami case. The dissemination of tsunami warnings is, in the first instance, from two types of warning towers activated from a central location near Bangkok. The first type is manned at the time of an emergency and is maintained and monitored by the Royal Thai Navy. The second type takes the form of automatic unmanned warning towers that have been installed along the beaches in the six provinces bordering the Andaman Sea. Both types emit a warning either as a siren or amplified verbal alarm. Immediately backing up these initial warnings is an Amateur Radio Network that disseminates warning information from 76 Control Stations (one in each province) via an Echolink System and normal frequencies in the amateur radio network to provincial users of these networks. These measures are illustrated in Figures 7.1 to 7.4.

The emphasis of the Thai government's approach is on clarity of responsibility and communications networks. Regarding the evacuation of people, there is a priority order and all villages must have arrangements for evacuation to safe areas. Areas designated as 'safe' are either outside the zone affected by the December 2004 tsunami or are on land higher than 15 metres above sea-level. These safe areas are, as far as possible, identified, advertised and signposted. Similarly, primary and alternative evacuation routes are identified so that all communities have at least two routes to safety. Learning

from the experience of the December 2004 event, the Thai government has recognized the importance of an effective telecommunications network that can support both the evacuation procedures and any post-tsunami provision of aid and effective logistic operations (DPM, 2005a).

Once a tsunami alert has been issued, and assuming it is then cancelled, the resident population will be able to return to their property, the return being managed by nominated community leaders in cooperation with evacuation officials. Where appropriate, the RCDDC coordinates with military units, government agencies, private companies (such as transport companies) and other organizations according to need. Overseeing the three phases is the National Disaster Warning Centre, which is operational 24 hours a day regardless of whether or not there is an emergency.

Evacuation, transport and information gathering

A lesson learned from previous emergency responses is that people, rather than flee, tend to remain in the area of danger (Whittow, 1980) putting additional stress on transport resources that may be required for purposes other than forced evacuation. In respect of information and emergency telecommunications, of major importance is the provision of timely and relevant information about relief operations to local, national and international audiences. Communications with those affected by the disaster are often neglected. Thus two main objectives are: first, to establish communications networks to facilitate and coordinate relief operations, ensuring that there is system connectivity to support the humanitarian effort and, second, to harmonize activities between the humanitarian community and government bodies to ensure effective communications and the maximum utilization of resources (United Nations, 2006). Although there is little specific reference in the Master Plan for Tsunami Evacuation to logistics requirements, effective transport of people away from danger, of supplies to displaced people and overall mobility to respond to rapidly changing circumstances are all implicit imperatives (Whiting, 2010; Heraty, 2010a; 2010b).

With specific reference to the 2004 tsunami disaster, the degree of disruption, coupled with the surprise element and the sheer scale of the emergency, generated a very high level of information inaccuracy. Getting a clear picture of conditions and needs on the ground was a key priority in the hours after the tsunami waves struck. This encouraged relevant agencies to engage in various triangulation techniques (a widely used information and data verification method) in order to iron out as much uncertainty and information conflict as possible. Subsequently, for this purpose, Banomyong *et al* (2009) proposed using two triangulation techniques known as data triangulation and investigator triangulation (Denzin, 1989; Denzin and Lincoln, 1998) to reflect as accurately as possible the 'real' situation on the ground. Data triangulation largely employs the use of published and unpublished papers, media coverage and on-the-ground reporting. Observations are backed up by data collected from several different secondary data sources such as

websites, published and unpublished research work, contemporary media coverage and tsunami inquiry reports. The purpose of the data triangulation technique is to provide a broad coverage of the literature that may relate to the incident, and to reconcile it with observations on the ground. Investigator triangulation involves comparing reports on the same event from the same location but from different observers; differences are then reconciled by repeat investigation. These techniques were unexpectedly put to the test in the spring of 2012 when seismologists observed sudden seismic activity centred on the eastern Indian Ocean.

11 April 2012 case event

'Tsunami!'

At around 15.40 local time on 11 April 2012 an earthquake of magnitude 8.6 struck, with an epicentre at 500 km west of Sumatra and at a depth of around 33 km. It was the Easter vacation period and tens of thousands of (mostly Western) tourists were resident in the resort areas of Thailand. Two of the authors, AB and SB, were among the holidaymakers at Railay Beach Resort, Krabi which offers a picturesque location, accessible only by boat from the mainland to the north or from offshore islands such as Phuket or Ko Phi Phi, 1–3 hours' sailing time away. At Railay Beach all hotels were full and the local population, including tourists, hoteliers, fishermen, boat operators, farm workers and local crafts people numbered around 2,000.

The largest single group was an extremely diverse body of international tourists, speaking a correspondingly wide range of languages, a fact which became relevant as the emergency unfolded. In approximate descending order, the tourists were from the United Kingdom, Sweden, France, Finland, Thailand, Norway, Singapore, Russia, Germany, the United States, Italy, Spain, Greece and Romania. Other nationalities were undoubtedly also represented, but were not identified specifically. This diversity was to prove relevant in the minutes and hours that followed the earthquake. As has already been discussed, the disastrous consequences of the December 2004 tsunami precipitated a major review of international emergency response systems at all levels. At a macro level, the most important improvement was the incorporation of the Indian Ocean into the established Pacific Ocean Tsunami Warning System during 2005. At a national level in Thailand, the Ministry of the Interior through the DDPMMI had overhauled all aspects of emergency response, including: building fixed towers to provide emergency siren soundings; installing improved information dissemination systems and chains of responsibility; establishing systems that warn communities in coastal areas of their vulnerability to tsunamis; and the erection of directional signs highlighting escape routes to higher ground. These measures are detailed in, for example, Pettit *et al* (2013), Banomyong *et al* (2009) and Beresford and Pettit (2007), and are illustrated in Figures 7.1 to 7.4.

FIGURE 7.1 Tsunami warning tower for manual and automated warning transmissions

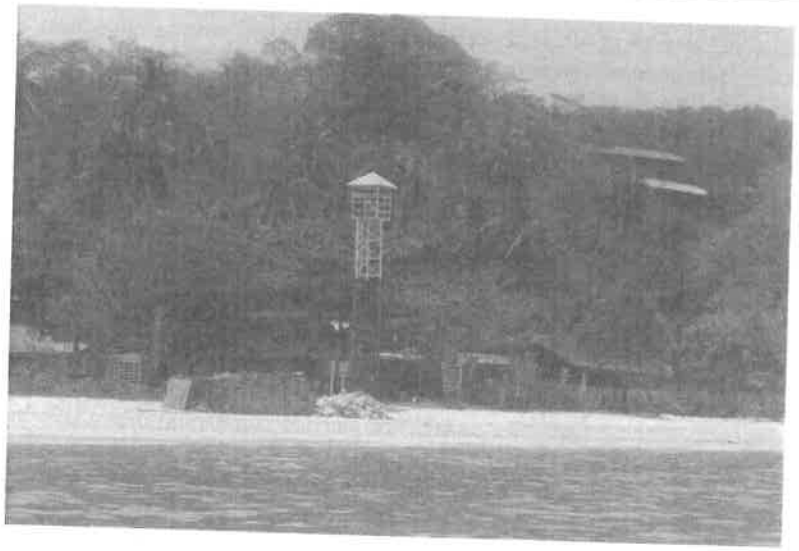


FIGURE 7.2 Radio operators briefed to carry out local warning dissemination

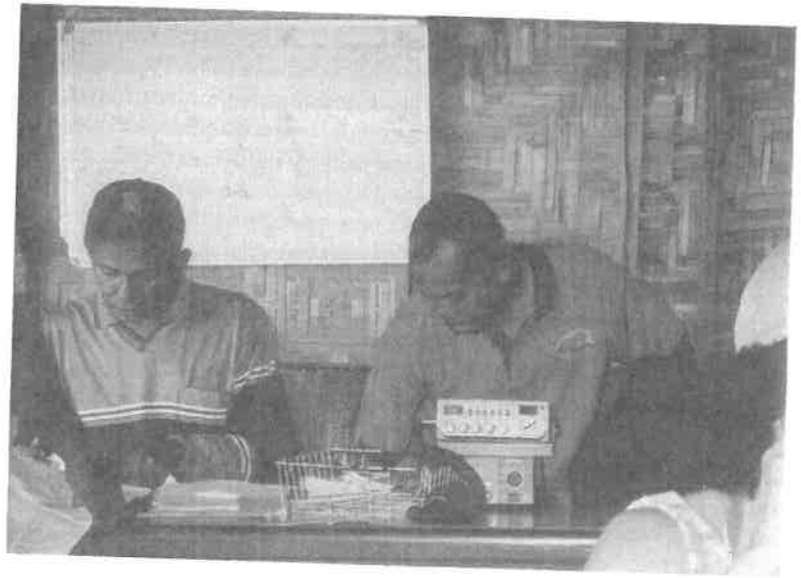


FIGURE 7.3 Tsunami evacuation sign

FIGURE 7.4 Hazard marker including depth of tsunami wave, 26 December 2004

'Human Logistics'

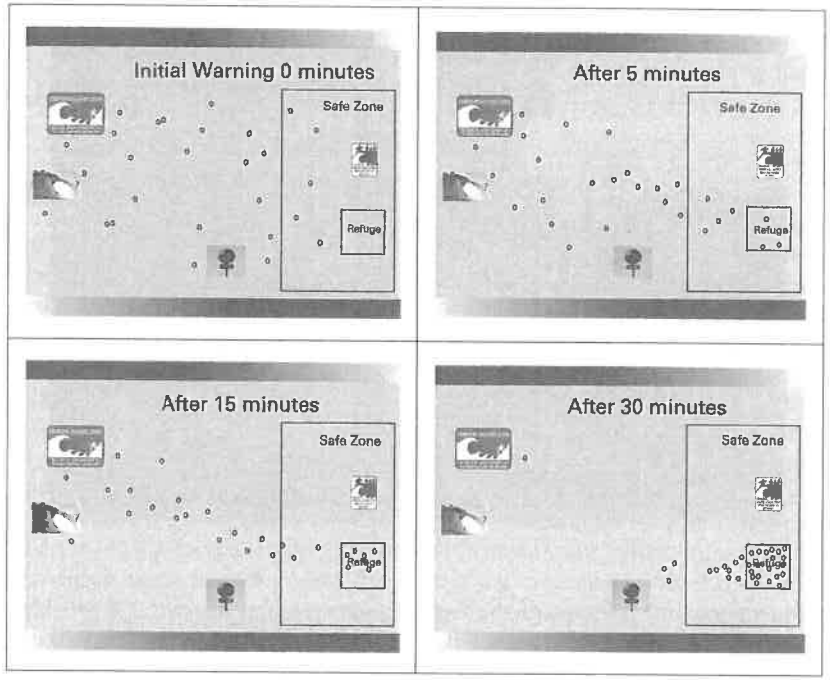
For the tourists and local inhabitants of Railay Beach, and other mainland resorts nearby, and on Phuket Island, the first indications that life on vacation was about to change was a low-key, word-of-mouth warning by hotel staff that an emergency was under way. Interestingly, due to the depth of the earthquake and its relatively distant epicentre, only a small minority of tourists felt the tremor. Staff walked purposefully but discreetly from group to group stating that an earthquake had triggered a possible tsunami and everyone, with no exceptions, was to make for high ground as quickly as possible. Around five minutes later, an official warning siren sounded and the hotel staff began donning life-jackets and guiding guests to the Railay evacuation routes. Remarkably in these few minutes, a significant number of tourists switched into 'denial' mode (often observed in an emergency) and went to their rooms or even the beach or pool for a swim. This peculiar behaviour soon ceased, however, as the large majority of people formed into an orderly line heading with some determination along evacuation routes.

In these early minutes the observed moods varied across the full spectrum: a clear concern was commonly observed, but fear, mild panic, determination, upset and confusion were all in evidence. Figure 7.5 shows a simplified schematic of people's movements in the minutes following the tsunami warning, with circles representing the distribution of individuals or groups. At the time when the tsunami warning was issued, people were widely distributed around the resort, located on the beaches (left side of each pictogram), in the hotel grounds (centre of pictograms), or in recreational areas (right side of each pictogram). Danger areas and evacuation routes are illustrated by means of warning and directional signs respectively. Higher safe zones and refuge buildings are shown to the right of each pictogram. It was noted that half an hour or so after the emergency siren sounded, a small number of individuals remained at the beach ignoring all warnings.

More positively, however, the availability of several smartphones with local SIM cards among the group meant that communication with other displaced people elsewhere in Thailand and with the outside world in general (eg to inform family members that people were safe) was possible. By stroke of fortune, among the tourist groups at Railay Beach, was an off-duty UNICEF staff member who was able to establish a phone link with the Ministry of the Interior, Bangkok. This enabled the group to obtain the best available information regarding the status of the tsunami warning itself as well as the situation in other locations in Thailand.

Further, this enabled the information reaching Railay Beach to be verified – or at least calibrated against information interpretation at, for example, west coast Phuket. This form of information triangulation proved invaluable when a second earthquake, of magnitude 8.2 on the Richter Scale, was reported and it was possible to verify that this was indeed a second earthquake rather than a later report of the first tremor. It was also possible to ascertain that, although a tsunami could have been triggered by this

FIGURE 7.5 Response behaviour post tsunami warning



second period of seismic activity, only very tiny waves had been generated by the shock. Investigator triangulation, referred to earlier in this discussion, therefore proved its worth as this potential emergency played out.

As the evacuation of the beach areas progressed it quickly became apparent that the signage (installed mostly in 2005) was inconsistent in terms of clarity and prominence. At one key location, for example, it was essential to turn left, not right, towards local high ground, but at the critical location there was no sign – this was therefore an omission that was potentially fatal. Nonetheless, within about 15 minutes of the official emergency warning, some 2,000 people were proceeding to around 15 metres above sea level along a steepening path at the back of Railay East having walked around 400 metres. This revealed a second shortcoming: no altitude signs were in evidence so, increasingly, tourists were asking each other, 'Are we safe yet?'

The diversity of nationalities and languages among the groups also proved an impediment, though simple English instructions tended to be the default. Nervousness among the groups was exacerbated by the lack of an obvious leader such as a senior hotelier or local administration officer; this led to various questions being asked by tourists several times before an answer was relayed around the groups. It was indeed disconcerting that

FIGURE 7.6 Tourists gathered at tsunami safe zone, approximately 30m above sea level

within about 30 minutes of the warning sirens many of the local workers and boatmen had, in fact, headed out to sea, having donned life jackets. One specific tourist enquiry as to what safety action to take triggered the response: 'Run for your life!'

That there were plainly dramatic contrasts between individual reactions to the emergency and lack of obvious leadership was a clear shortcoming. Other difficulties arose minute by minute. There were, for example, no special arrangements for the elderly, infirm, very young or disabled and a large number of evacuees were starting to regret heading immediately to safety, remembering that passports, money, documents, clothes, camera, phones and other belongings had been left behind. Very understandable emotions of regret, frustration and even anger started to be in evidence and probing questions were repeatedly being asked: 'When will the wave come?', 'What happens next?', 'How long will we be up here?' and 'Could the wave reach us?'. The main tourist group gathered at the safe zone at around 30 metres above sea level, shown in Figure 7.6. Some tourists also chose to climb higher to the nominated safety refuge at 35 metres above sea-level (Figure 7.7).

Prevailing emotions by now had become disorientation and frustration, and tourists were now questioning the need to remain at the refuge when the danger could well have passed; a feeling of being 'temporarily displaced refugees' was by now common among the group. Observations were also being made regarding the conduct of the hotel employees and of the refuge facilities themselves: for instance, there was a clear need for stronger leadership

especially in the area of information provision and situation updates. The important question of 'who is in charge?' remained unanswered for the duration of the four-hour stay at the refuge, but the overriding point was that we were safe. At a practical level, the refuge lacked even basic facilities or communication tools such as information boards, staff tables, flags, megaphones or signs.

'Can we go back now?'

After two hours or so in the evacuation zones the mood among the displaced tourists again began to change: Questions such as 'Where can we get some food or drink?', 'Do we need to stay up here much longer?', 'Why hasn't there been a tsunami?' and 'If there is a tsunami will our hotel still be there?' began to be asked.

For at least an hour from around 6 pm to 7 pm local time, continuous attempts were made to establish whether or not there remained a danger of a tsunami. The range of information-gathering techniques increased: television bulletins combined with smartphone real-time communication, texts, Twitter, Facebook and e-photography transmission all played a part in establishing facts and separating truth from rumour. Photo-images of the retreating tourists performing the emergency evacuation which had been taken by the tourists on boat-trips, began to be received by the group at the refuge (see Figure 7.7). Several boat-loads of tourists, about to dock when the tsunami warning siren sounded, headed back out to sea in accordance with marine safety procedures, and they remained at sea for three hours or more while the warning remained in force.

An unexpected negative consequence of the wide range of information sources was the problem of 'circular reporting'. Put simply, this is the repeated reporting of the same event by observers in different locations around the globe. This leads to an impression that a new emergency event, eg a fresh earthquake, has just occurred whereas in fact it is the original event being reported by a group far distant, and hence several time zones, from the original emergency announcement.

The problem is particularly common now with a global information network which enables communities to receive new messages with potential ambiguity regarding when the event actually took place in relation to distant communities' local time which could be dislocated from the emergency by 11 to 12 hours, though the information reaches those communities virtually instantaneously.

After around three hours at the refuge with the time locally ticking past 7 pm, dusk approached bringing further unwelcome consequences. Although the refuge was located on the edge of a hotel complex, the relative remoteness of the site meant that tracks to, from and around the site were rough and inconsistently lit. The site was also on a steep slope with the result that moving around the site was itself hazardous. Other unwelcome aspects to

FIGURE 7.7 Tourists in covered refuge, approximately 35m above sea level

the lengthening wait for the 'all clear' was the shortage of water, the high humidity, wearing of inappropriate and uncomfortable clothing and a growing number of mosquitos and other insects.

Although a very welcome soup kitchen was organized, the overwhelming wish at Krabi was to hear an '**ALL CLEAR**' announcement which had been given sometime earlier (around 7 pm) at resorts on Phuket.

'All Clear!'

The '**ALL CLEAR**' siren finally came at around 8.15 pm. Ironically, this was difficult to distinguish from the emergency sounding four hours earlier, so there was some initial confusion as the siren was interpreted by some tourists as another emergency. The siren was accompanied by a message transmission which was also very disconcerting: 'Return to hotels, clear debris and pick up bodies.' This was, thankfully, not necessary but this closing communique was clearly in need of a review.

Emergency response: a field survey

Being caught up in a real-time emergency presented two of the authors, AB and SB, with a unique opportunity to experience, observe and examine Thailand's tsunami response mechanisms directly and in earnest. In order to make the best sense of individuals' reactions to the emergency warning at the time, a series of 46 on-site, informal interviews was carried out during

the evening of the 11 April tsunami warning and during the following day at Railay Beach Resort.

The dimensions of the interview programme are presented in Tables 7.3 and 7.4 which also highlight the contrasting behavioural responses of the four interview groups. The four individuals making up Group A generally behaved in a coordinated way but they were split into two subgroups of two during the walk towards the refuge. This group was able to obtain additional information via smartphones from other friends and family who were, coincidentally, simultaneously spending the Easter vacation in Phuket. The second group, B, was also small and comprised professionals who de facto took informal charge of the information-gathering and dissemination process. Group C, hotel staff, again consisted of two sub-groups who, respectively, left the resort by boat to join families living in the vicinity, or remained at the Railay Beach resort and played an active and positive role in the retreat to the refuge and in operational aspects of the refuge itself. The final group of interviewees (Group D) was the largest, being a diverse group of tourists who were happy to contribute to the information-gathering exercise. This group, comprising at least 14 different nationalities, provided rich information both in the form of comment, and also by virtue of behavioural variations. All interviewees consented to having their anonymised views collected and, in due course, disseminated. One clear message that emerged from the diversity of the groups was that, which such a variety of native languages in use, safety messages and information dissemination had to be extremely clear, simple and unambiguous. Signage and messaging must be simple to avoid misinterpretations, misunderstandings or, at worst, incorrect responses.

The 11 April 2012 tsunami warning at Phuket, Krabi and adjacent provinces provided two of the authors with a unique and unexpected opportunity to field test Thailand's warning and response systems put in place after the December 2004 tsunami. A range of responses in the form of hard systems (eg warning towers, signs and evacuation routes) and soft systems (information dissemination, leadership structures, general education and awareness) were put into place during 2005 and thence tested in earnest in 2012. In the minutes immediately following the 2012 alarm it quickly became clear that, in the face of a pending emergency, individuals behave in very different ways. The design of the emergency response systems, both hard and soft, clearly must take account of human behavioural variations; in a real emergency these can make the difference between survival and loss of human life.

Conclusions

The earthquake and the resulting tsunami on 26 December 2004 claimed approximately 230,000 lives and displaced 1.7 million people. The damage

TABLE 7.3 Interview programme and profile of respondents

Group A	Group B	Group C	Group D
Friends and family	Profs / UN	Hotel staff	International tourists
4	4	11	27, Diverse range of nationalities, narrow age range >80% 45 or less
French / British	NZ / British	Thai	British, French, US, Russian, German, Finnish, Norwegian, Swedish, American, Thai, Spanish, Italian, Romanian, Greek
Behaved as close unit although split at first; also comparator group in Phuket	Took charge and established link to Min. of Interior	2 sub groups– SG1 opted out and sailed home, SG2 organized information and food and drink– also coordinated with AKCB and UN staff	Disparate and showed very varied reactions from upset to inquisitiveness to 'let's party' to 'let's make best of it' and organize seating areas, food, drink etc; 5 Americans on boat trip mixed behaviours: panic sttacks, asthma, trips, slips, knocks

TABLE 7.4 Timeline of tsunami warning and evacuation

	Index*		Timeline
Pre Event	1	Tsunami Warning Infrastructure – hard and soft, chain of responsibility; hazard assessment process filters; stable pre-warning conditions	
Event		Earthquake 8.7, 500 km off Indonesia, 33 km deep – Tsunami?	3.40 pm
Phase 1	8	Warning of possible from Pacific – Indian Ocean Min. of Interior.	3.45 pm
Phase 2	9	Immediate response: mobilization, speed of information, poor signage	First 15 min
Phase 3	8	Movement to high ground complete, roll-call.	15 –30 min
Phase 4	5	Information that no tsunami reported by ships at sea, satellite, other sources. Could be aftershocks then tsunami	Return by 6.30 pm could be possible
Phase 5	9	Sudden report of 2nd quake, 8.4? and tsunami of 3.5 m expected as quake involved subduction	
Phase 6	4	No reports of tsunami, and 3.5 m wave was incorrect information. Mis-reporting of 3.5 cm mini-wave	Probable/ possible return by 7.30 pm
Phase 7	2	Information gathered by twitter and Facebook (also text) that Phuket evacuation over	Full return implemented by 7.30 pm
Phase 8	1	Final clearance to go down at 8 pm, slow response	8–8.30 pm

* Level of concern

to infrastructure was huge. The world responded by donating more than US $13 billion initiating the largest relief operation in history. The plethora of assessments and after-action reports showed beyond reasonable doubt that there was a compelling need to improve humanitarian response, and the best way of achieving this in the future is to be better prepared by having robust response structures in place and to act appropriately after an emergency warning is triggered.

While 72 per cent of the humanitarian organizations who responded to the Indian Ocean tsunami had an assessment process that enabled them to plan for relief in the tsunami region, 62 per cent of them stated that their plans failed to meet needs. 88 per cent of the assessment team members were internationals and 38 per cent of organizations had assessment teams from the affected areas. Only 58 per cent of organizations used logisticians in their assessment teams – a fact that undoubtedly contributed to failure to anticipate some of the logistics bottlenecks that were experienced (Banomyong *et al*, 2011).

One of the starkest messages the 2004 tsunami disaster provided was that the effectiveness of emergency response hinges on both information dissemination and logistic efficiency. It is imperative that, for humanitarian logistics to adequately serve the purpose of successful delivery of aid, the humanitarian aid organizations at large must recognize the role that logistics plays in the delivery of programmes large and small, and the need for humanitarian logistics to be adequately resourced in terms of trained and capable staff, adequate information management systems, and logistics infrastructure.

In many areas the lessons identified as a result of the Indian Ocean tsunami 2004 remain just that – lessons identified – they cannot qualify as lessons learned. Only in specific areas such as disaster planning and preparedness, for example in Thailand, have lessons been learned. The key factor is that, with the greater incidence of concurrent sudden-onset natural disasters affecting the lives and livelihoods of more and more people, focus needs to be on building national and regional capacity and developing robust national and regional disaster and response plans – the success of this approach in Thailand is clear.

In the context of the 11 April 2012 tsunami warning, information dissemination and interpretation were paramount. The effectiveness and speed of response of local organizations and tourists was determined in the first instance by the top-down emergency warning systems put in place since 2004. When an earthquake magnitude 8.6, and then a second earthquake magnitude 8.2, struck just two hours later with epicentres approximately 500 km off Sumatra the response systems in Thailand were tested to the limit. The two tremors were in almost the same location as the 2004 earthquake that had devastated Banda Aceh. The local responses of both the Thai authorities and the visiting population provided an opportunity to observe events in real time. It was clear that, with current warning systems, evacuation mechanisms and chains of responsibility at a local level,

large numbers of people can be moved quickly to safe zones. However, several systemic weaknesses were also found to be both important and potentially critical. Evacuation route signage had become inconsistent, particular mobility needs at an individual level were not catered for, leadership in crisis conditions was weaker than required in the circumstances, and greater filtering of information to establish fact from rumour during the emergency warning period was needed. There is, therefore, still substantial room for improvement, especially at a local level, in Thailand's overall tsunami response system. These improvements are of an organizational or procedural nature, rather than the installation of expensive additional hardware.

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