

**CHAOS THEORY AND THE ROLE OF EXPERT ANALYSIS AS A PERIODIC
ATTRACTOR DURING THE 2004 INDIAN OCEAN TSUNAMI**

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ABSTRACT

The 2004 Indian Ocean Tsunami was epic in scale and scope and will go down as one of the largest natural disasters in human history. This paper presents an analysis of media coverage of the disaster and surveys of 206 local and international tourists in Khao Lak, Thailand, through the framework of chaos theory. Specifically, this paper examines the role of expert analysis as a periodic attractor during and after the tsunami. It will demonstrate how expert analysis brought disparate images and eyewitness testimony into greater focus, creating order in an otherwise chaotic environment.

Keywords: *2004 Indian Ocean Tsunami, chaos theory, periodic attractors, and expert analysis, Khao Lak, Thailand.*

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1. INTRODUCTION

This paper presents an examination of the 2004 Indian Ocean Tsunami and the influence of media analysis on the perceptions of 206 local and international tourists surveyed in Khao Lak, Thailand, through the use of chaos theory seven years after the disaster leveled the seaside resort. Specifically, this paper focuses on the role of expert/technical analysis as a periodic attractor and the effect knowledge creation has had on making the event understandable, thus, reducing anxieties related to it. When applied to the 2004 tsunami, chaos theory provides a paradigm for understanding the disparate images immediately following the disaster as coverage turned from disaster display to disaster analysis.

A crisis is an event with low predictability but high impact demanding explanation, analysis, and accurate information usually from experts and other professionals (WEICK K. 1995; SEEGER M. AND SELLNOW T. 1998). The 2004 tsunami was an unprecedented crisis for several reasons, two of which were its scale and the video/photographic evidence captured by individuals caught in the midst of the disaster. The tsunami was generated by an earthquake measuring more than 9.0 on the Richter scale off of the western coast of Northern Sumatra and devastated the shores of India, Indonesia, the Maldives, Myanmar, Sri Lanka, and Thailand. It was an epic disaster killing and displacing close to 300,000 people from Asia to Africa. Six coastal provinces along the Andaman Coast of Thailand were devastated; the affected areas included 25 districts, 95 *tambons*, and 407 villages with 47 villages completely destroyed (UNRC 2005). Hundreds of local fishing communities were leveled while more than 100,000 people lost a home or family member.

The destruction of Khao Lak was almost total. Most of the town's coastline including resorts, vegetation, and beaches were destroyed. SEI International (2009) cites the damage as resulting primarily from the shallowness of the offshore ocean shelves, low onshore elevations, and the large number of wooden and non-reinforced concrete structures along the coast. Over 4,000 of the more than 5,300 people who died in Thailand perished in Khao Lak, while unofficial estimates put the number at more than 10,000. In addition to the loss of life, approximately 90% of all housing in the region was either partially or totally razed.

Media coverage of the tsunami was longer than any other previous natural disaster and continued through January 2005 (WYNTER A. 2005). CNN had more than 80 personnel providing 24-hour coverage, as did other global and regional networks. The ongoing catastrophe dominated the front page of periodicals such as the New York Times, Time, Newsweek, The Economist and many others for weeks following the event (BROWN P. AND MINTY J. 2006).

With the rise of 24-hour news channels and dissemination of videos and photographs via the Internet, exposure to disasters such as the 2004 tsunami are now commonplace. This trend will likely increase with technological advances, the spread of internet connectivity, and the use of social media applications. However, disseminating images of disasters in a constant loop has a significant impact on those immediately affected as well as the broader public. Post-traumatic stress disorder (PTSD) and post-traumatic stress symptoms (PTSS) are now recognized as common products of repeated exposure.

Previous research has also demonstrated the effect of witnessing death and graphic images on television and the development of PTSS in children (NADER K. ET AL. 1993). Exposure to scenes of

terrorism, likewise, have been shown to increase levels of anxiety in test subjects in Israel (Slone M. 2000) and middle school students in the US state of Oklahoma following the bombing of the Murrah Federal Building in Oklahoma City (PFEFFERBAUM B. ET AL. 2001). In the wake of the 9/11 attack on the World Trade Center in New York City, a study of schoolchildren exposed to negative and positive (i.e. heroic) images from the attack found increased PTSD symptoms with the highest levels among those exposed to images on the Internet (SAYLOR C. F. 2003).

Following the 2004 tsunami surveys of residents in Hong Kong who viewed media coverage of the disaster repeatedly found similar increases in anxiety related disorders (LAU J. ET AL. 2006). However, media coverage was not restricted to images of the tsunami. In a separate study of survivors in India, researchers found that scientific and technical analysis provided by experts via television news reports eased tensions among those at risk (SRI JOTHI P. AND NEELAMALAR M. 2011). While PTSD for the general public witnessing such events electronically can occur, its severity is lower than that experienced by victims and significantly diminishes over time (NERIA Y. AND SULLIVAN G. 2011).

The widespread media coverage of the tsunami demonstrated the unpredictability of natural disasters and the devastating consequences, which can accompany them. The fact that the tsunami was caught on film by tourists while on holiday added another layer to that unpredictability, turning on its head an otherwise structured setting into one of chaos. Yet, it was through these firsthand images that order within the chaos began to emerge. As initial reports surfaced, the unpredictability of the disaster was assessed by scientists who provided key information regarding earthquake-generated tsunamis. Thus, information was not value free but fell within parameters defined by expert analysis.

While initial images of the disaster were ad hoc, varied, and presented in real time as information came in from throughout South and Southeast Asia, these impromptu field reports gave way to knowledgeable experts who presented the tsunami as a natural event with understandable causes. Unlike terrorist activities, which can originate from diverse sources and have multiple catalysts, expert analysis of the disaster presented objective reasons establishing a degree of order within a chaotic system.

The paper begins with a section on the limitations and origins of the study before detailing the methodology and demographic indicators of those surveyed. It will then provide a discussion divided into four parts. The first part presents an overview of Khao Lak and the 2004 tsunami. As will be seen, while an obvious recession in tourism occurred immediately after 2004, Khao Lak's status as an 'undiscovered' part of Thailand has been a draw for many tourists and over the years the town has built up a loyal following which helped sustain the area immediately after the disaster.

The second part examines current perceptions of Khao Lak, knowledge of the tsunami, and how this knowledge has influenced anxieties related to natural disasters along the Andaman Coast. This is followed by an examination of media coverage of the 2004 tsunami via chaos theory and specifically the role of expert analysis as a periodic attractor. The final section details external events since the disaster, which have contributed to the easing of tensions in the years that have followed.

1.1 Scope and Limitations

Research for this study was originally part of a larger project examining tourism redevelopment in Khao Lak seven years after the tsunami. As the original project did not focus specifically on expert

analysis as a mitigating factor in reducing anxieties related to the tsunami, certain questions were not included in the surveys as they were not under examination. For example, while questions were asked regarding knowledge of the disaster, its effect on travel plans, and the sources used in researching Khao Lak, questions pertaining to the direct effect of television and newspaper coverage at the time of the tsunami were not. Although it is acknowledged that due to this limitation the conclusions drawn are not definitive, the paper's main objective is to present a theory of how expert analysis of natural disasters through the dissemination of technical and scientific information reduces anxieties over time.

There were two further limitations in the original study. The first was that surveys were conducted during mid-October, 2011, which is the low season in Khao Lak. Although 206 surveys were completed, the number is likely less than that had they been conducted during the high season, roughly November – April. The second limitation is the inherent issue of conducting surveys of travelers on vacation and their motivation to participate in a study of a sensitive and potentially offensive subject matter. Although a small number of individuals chose not to take part in the study, in general people were willing to participate in the surveys and interviews.

2. METHODOLOGY

A comparative study of tourists and the experiences of Khao Lak's community are presented alongside an examination of the area's recovery. Research was conducted in October 2011 and consisted of surveys and interviews of 206 foreign and Thai tourists and 22 local Thai residents and business owners. The surveys were designed to gain insight into tourists' knowledge of Khao Lak, knowledge of the 2004 tsunami, and the perceived threat of natural disasters along the Andaman Coast. Interviews were conducted of local Thai business owners and residents in Nang Thong Beach and Biang Niang Beach. These individuals represented owners of restaurants and clothes shops, beach vendors, taxi drivers, dentists, internet café owners, pharmacists, optometrists, and travel agents. As the majority of those interviewed lived through the tsunami and Khao Lak's reconstruction, their views are a necessary part of any study of perceptions of the region.

Section 4.3 examines the role of media exposure and an increase in knowledge of the tsunami along with a decline in anxiety and association of Khao Lak with the event through the paradigm of chaos theory, and specifically expert analysis as a periodic attractor. First proposed by Lorenz (1963) who described how minor fluctuations in weather systems can lead to unpredictable and wide-ranging outcomes, chaos theory has been applied extensively from medicine to the social sciences. Chaos does not necessarily imply a lack of order as order and predictability may become evident as crises unfold.

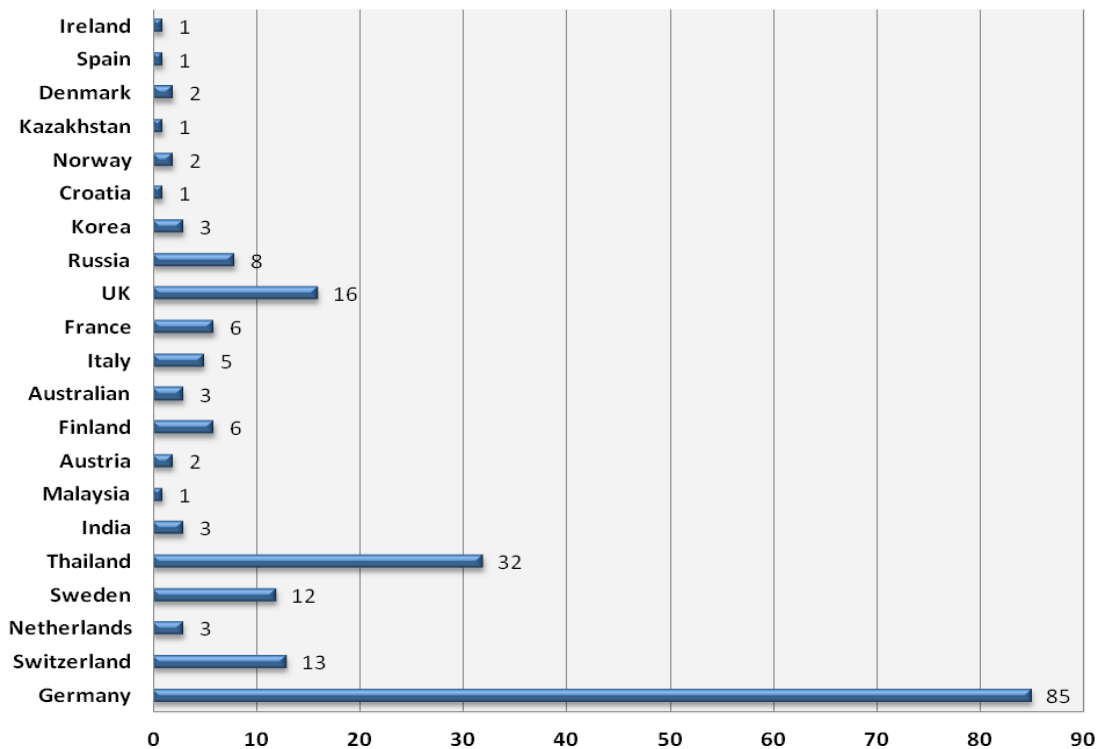
The application of chaos theory in this paper follows the work of Sellnow et al. (2002) on communication within natural disasters but differs through the focus specifically on the role of expert and technical analysis as periodic attractors. Attractors are organizing principles created within complex systems and have limited values that define their boundaries. Thus, periodic attractors represent systems that settle into a cycle with defined roles, periodically achieving stability (THIÉTART R. AND FORGUES B 1995). While no one can predict the exact state of a system at any one time, it is known that they will be somewhere within the cycle.

2.1 Survey Population and Statistical Methodology

Surveys were conducted along Khao Lak Beach, Nang Thong Beach, and Biang Niang Beach. Respondents were divided into three principle categories: European/Western (80%), Thai (16%), and Other Asian/Indian (4%).

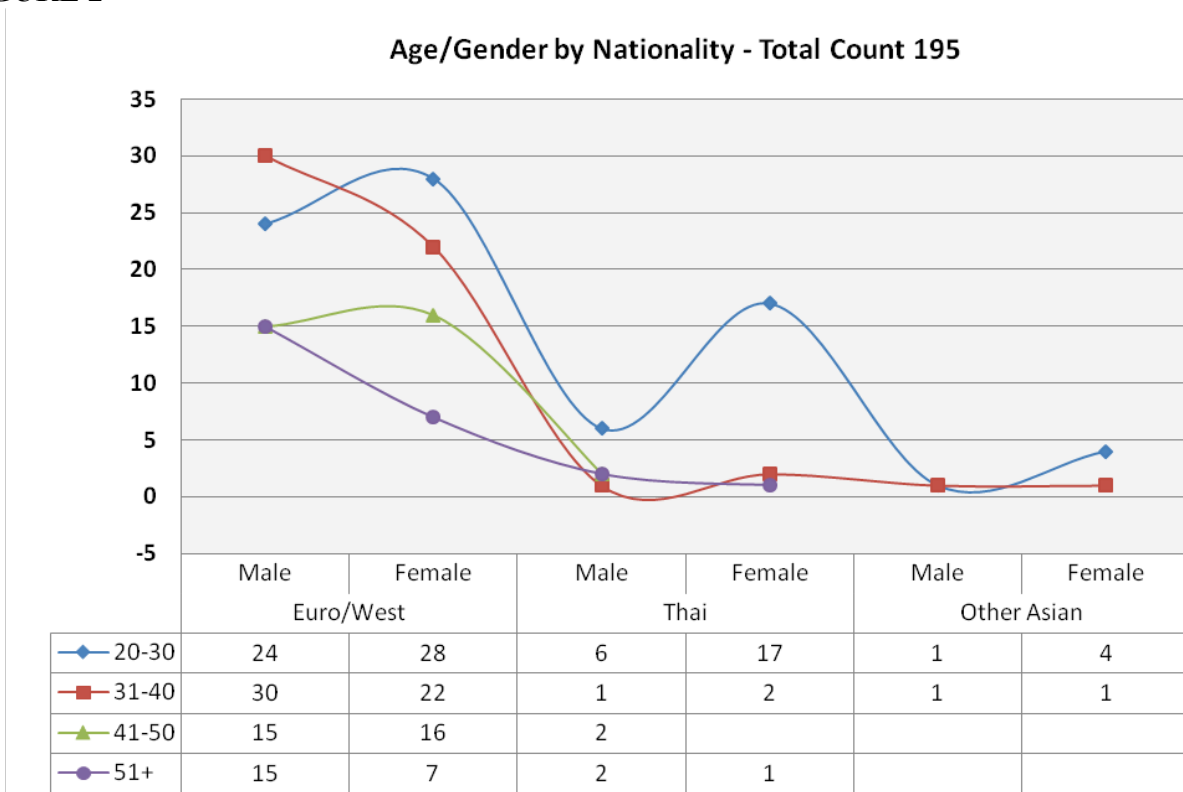
FIGURE 1

Respondents by Country of Origin - Total Count 206



Each category was further subdivided according to age, gender, and the number of previous visits individuals had made to Khao Lak. The sample was balanced with 49.7% male and 50.2% female respondents from 22 countries with the majority coming from Europe, specifically Germany. Nearly 75% of all foreign and 73% of all Thai respondents were visiting Khao Lak for the first time. Univariate statistical analysis was conducted on factors related to knowledge of the 2004 tsunami and perceptions of danger regarding natural disasters along the Andaman Coast; multivariate analysis was conducted on factors related to knowledge of the 2004 tsunami and its influence on travel plans to Khao Lak.

FIGURE 2



3. RESULTS

Summary of findings:

- Knowledge of the 2004 tsunami among foreigners and Thais was high.
- The tsunami’s influence on travel plans for foreigners and Thais was low.
- Most foreigners and Thais did not think the Andaman Coast was dangerous in terms of natural disasters.
- The more individuals knew of the tsunami, the less it influenced their travel plans.

Although the tsunami’s legacy has left a lasting impression on the region, this study demonstrates that it has not left the perception that the Andaman Coast is dangerous in terms of natural disasters. As noted above, German tourists represented the largest nationality, similar to pre-2004, followed by Thai tourists comprising 16% of respondents; this was higher than the 10% estimate given by Thai merchants interviewed in Khao Lak.

While respondents described their knowledge of the tsunami as high, the lasting effect of the tsunami on their travel plans was described as low. Further, there was not a direct relationship between the tsunami’s legacy, perceived dangers along the Andaman Coast, and Khao Lak in general.

Although respondents were well aware of the disaster, it was a generalized knowledge and not connected with one specific location.

The most important finding, though, was that the more respondents knew of the tsunami, the less of an effect it had on their choosing Khao Lak as a holiday destination. The Internet and travel guides were cited as the main sources of information regarding Khao Lak. However, given the extent of the tragedy and the dominance it held over media of all types during and up to several months after the event, an inference is made that expert analyses via television, print, the Internet, or a combination of all three were influential in creating greater awareness and reducing anxieties related to earthquake generated tsunamis. These findings reflect the role of expert analysis as a periodic attractor, establishing a degree of order during the disaster, thus, making an otherwise rare and enigmatic event understandable and reducing subsequent anxieties related to it.

External events also overshadowed the tsunami's legacy and helped reduce negative imagery associated with Khao Lak. These include the 2006 military coup ousting Prime Minister Thaksin Shinawatra from power; the 'red-shirt' protests of 2009 and 2010; a military conflict with Cambodia over the historic Preah Vihear Temple in northeastern Cambodia; the election of Prime Minister Yingluck Shinawatra, Thailand's first female prime minister and sister of Thaksin Shinawatra, in 2011; and other natural disasters such as the severe floods in late 2011 in central Thailand which severely affected the capital, Bangkok, as well as the country's manufacturing and tourist sectors. Combined with other studies of the mass media's impact during natural disasters (SELLNOW T. ET AL. 2002), evidence from Cognitive-Based Therapies in stress reduction (NIMH 2009), as well as those affected by the 2004 tsunami (SRI JOTHI P. AND NEELAMALAR M. 2011), this study presents indirect evidence of the mass media's role in reducing anxieties surrounding crises while providing a model for how this mitigation occurs.

4. DISCUSSION

4.1 Khao Lak and the 2004 Tsunami

Khao Lak is located in Takua Pa district in the southwestern Thai province of Phang Nga. The area is well-known for its proximity to national forests and the Similan Islands and frequented by scuba divers and naturalists. Situated an hour's drive north of Phuket, Khao Lak comprises the communities of La On, Bang Niang, Khuk Khak, Pakweep and Bang Sak. While 'Khao Lak' refers to the beach itself, the area now connotes the entire area extending north of Coral Peninsula to Bang Sak Beach. The town is seen as out-of-the-way by many tourists, which has led to the development of a distinct identity: quiet, family-friendly, and lacking the high-rise hotels and condominiums of other popular destinations.

Prior to tourism locals were employed in fishing, tin mining, and agricultural industries such as rubber and coconut plantations. The area rarely saw foreign tourists and it was not until 1987 that the first resort was established along with dive trips to the Similan Islands. By the 1990s the tourism industry began to expand rapidly and in a little more than a decade the town went from a sleepy fishing village to a fast growing tourist destination. Following this transition, Khao Lak came to rely almost entirely on tourism.

Although growing in popularity, by the end of the 1990s Khao Lak was still a low-key getaway for European tourists and an alternative to urbanized destinations. Local ordinances were established limiting building heights and noise levels to help maintain its quiet image. Facing west with heavy downpours during its low season from June to November further ensured that development did not increase unchecked.

Following the tsunami the region experienced a sharp drop in tourism; yet, despite the upheaval Phang Nga and Khao Lak made a considerable comeback. By 2005 schools were reopened and close to 75% of all students returned to classes (UNRC 2005). Tourism also began to recover the same year with the German market returning the quickest followed by the Scandinavian and UK markets growing by 6% and 8% respectively (TOT 2005). This was due in part to the work of some savvy business owners who turned the event to their advantage by highlighting their situation to international markets. East Asian tourists were the slowest to return, a decrease attributed in part to a lack of knowledge and media coverage, which gave the impression that the entire country was devastated (ibid). The numerous international volunteers that arrived in Khao Lak to help in cleanup efforts likewise aided businesses and even helped create new tourist markets (SEI 2009).

By 2007 tourism levels returned to those of 2003. The majority of hotels in the region had reopened and local fishing villages were re-established. Government programs, such as low interest loans for hotel owners in Phuket and Khao Lak as well as social services for affected villages, were part of broader efforts by local and international partners to spur redevelopment. Due to the efforts by the Thai government, local and international NGOs, along with those of local business owners, land prices in Khao Lak increased by as much as 40% in 2006 (CHIEN D. AND FITZGERALD C. 2006).

One of the most significant differences between Thailand and its regional neighbors regarding the tsunami relates to the level of destruction the country experienced. As destructive as the tsunami was, it was far less than that experienced by Indonesia with an estimated 220,000 dead, Sri Lanka with 35,322 dead, and India with 12,405 dead. And although Indonesia was the first hit and suffered the most damage, it was also the last to receive relief while Sri Lanka lost hundreds of square kilometers of agricultural land to the inundation. A lack or destruction of infrastructure in all three countries further hampered relief efforts and likely led to higher death tolls in the days and weeks that followed.

In addition to the hundreds of thousands that perished, the tsunami caused hundreds of millions of US dollars worth of damage. However, despite affecting six provinces, disaster areas in Thailand differed from those in the above countries through the use of airports in Phuket and Krabi soon after the event. Thus, flights from Bangkok were able to ferry aid into disaster zones while ferrying victims out. The use of these facilities likely staved off a much higher death toll and shortened Khao Lak's recovery time in comparison to other devastated areas in the region.

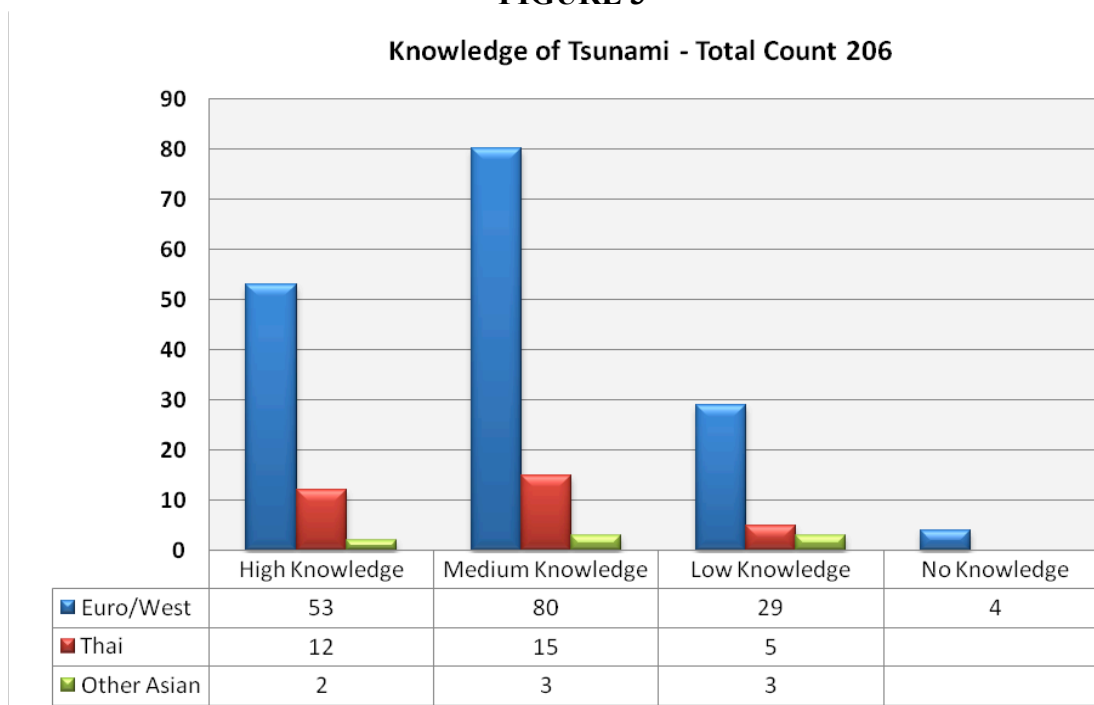
4.2 Influence of 2004 Tsunami on Travel to Khao Lak

The fact that Khao Lak is primed to become one of Thailand's newest resort destinations is indicative of the fact that perceptions of the region have changed. The long term impact expert and technical analysis has had on current perceptions of Khao Lak cannot be stated with certainty by this study given the limitations outlined in Section 2. As noted, though, the event was covered by media of all types as no other natural disaster was covered before. Further, more than 70% of survey respondents cited the Internet and travel guides as their primary sources of information regarding

travel to Khao Lak. When taken together, it is apparent that visitors to Khao Lak are well aware of the events of 2004 and use multiple sources to make informed decisions prior to travelling.

This broad exposure has led to an increase in knowledge of the 2004 tsunami while limiting Khao Lak's connection to it. Approximately 80% of respondents described their knowledge of the tsunami as 'medium' to 'high' on a 4-point scale, including 81% of all Europeans/Westerners and 84% of all Thais.

FIGURE 3



Further, 30% of Europeans/Westerners and 31% of Thais surveyed noted that their knowledge of Khao Lak fell within a similar 'medium' to 'high' range. However, of the total amount of respondents surveyed (206) only 29% reported that their knowledge of both Khao Lak and the tsunami fell within a 'medium' to 'high' range. What was more telling was that the vast majority of all respondents, 80%, noted that the tsunami had 'low' to 'no' influence on their travel plans.

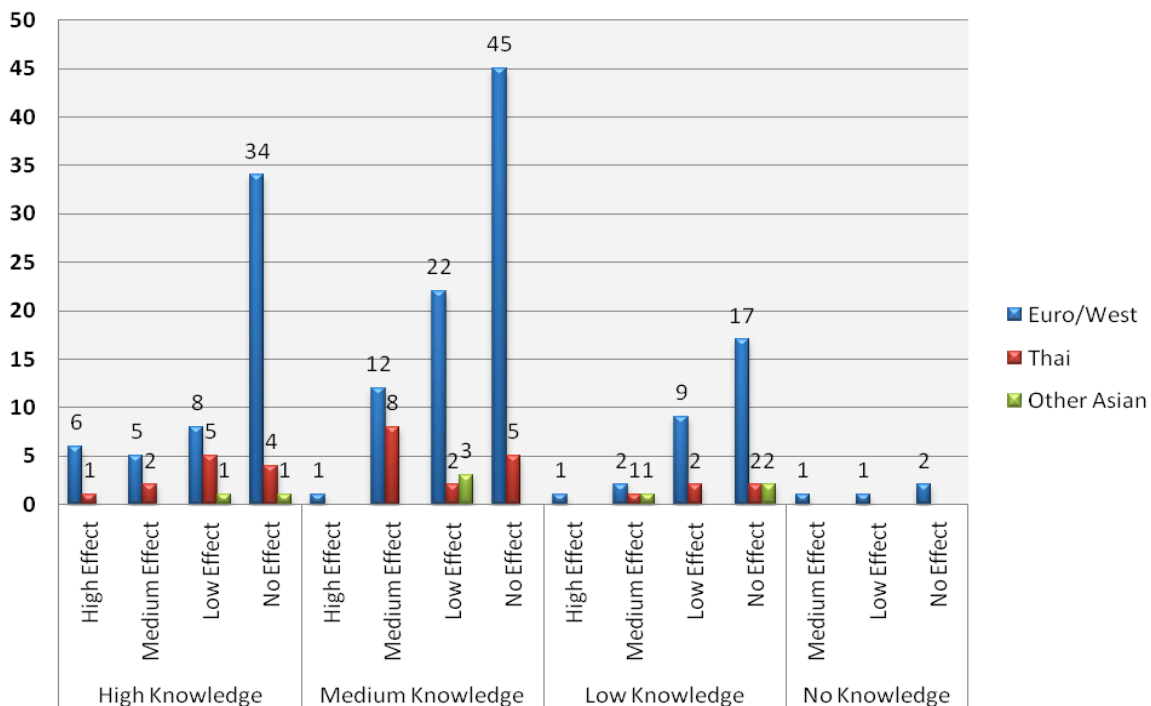
One of the most significant findings, though, was that the more individuals knew about the tsunami, the less it affected their travel plans. More than 63% of those who described their knowledge of the disaster as 'medium' to 'high' also described it as having 'low' to 'no' affect on their travel plans. This data offers support for the conclusion that widespread media reporting of the disaster created a greater awareness of the event through analysis of earthquake-generated tsunamis. This awareness likely reduced the disaster's influence on travel plans to Khao Lak through educating individuals (both local and foreign) as to how tsunamis such as the one in 2004 are generated. At the same time, this has reduced Khao Lak's connection to the disaster and the specificity of areas destroyed.

This lack of specificity can also be attributed to the scale of the disaster and the fact that numerous

countries were struck by the tsunami, as well as the comparative level of destruction Khao Lak experienced and its relatively quick recovery compared to other countries. When coupled with the extensive media coverage which focused on the causes of the tsunami and the regional nature of the disaster (particularly in the case of Western media), this has likely reduced Khao Lak's connection to the disaster as reported by foreign tourists while remaining stronger among Thais. Of those Thais surveyed, close to 22% who described their knowledge of the tsunami as 'medium' to 'high', described its influence on their travel plans as 'low'. However, more than 40% of Thai respondents who described their knowledge of the event in similar terms cited its effects on travel plans as 'medium' to 'high'.

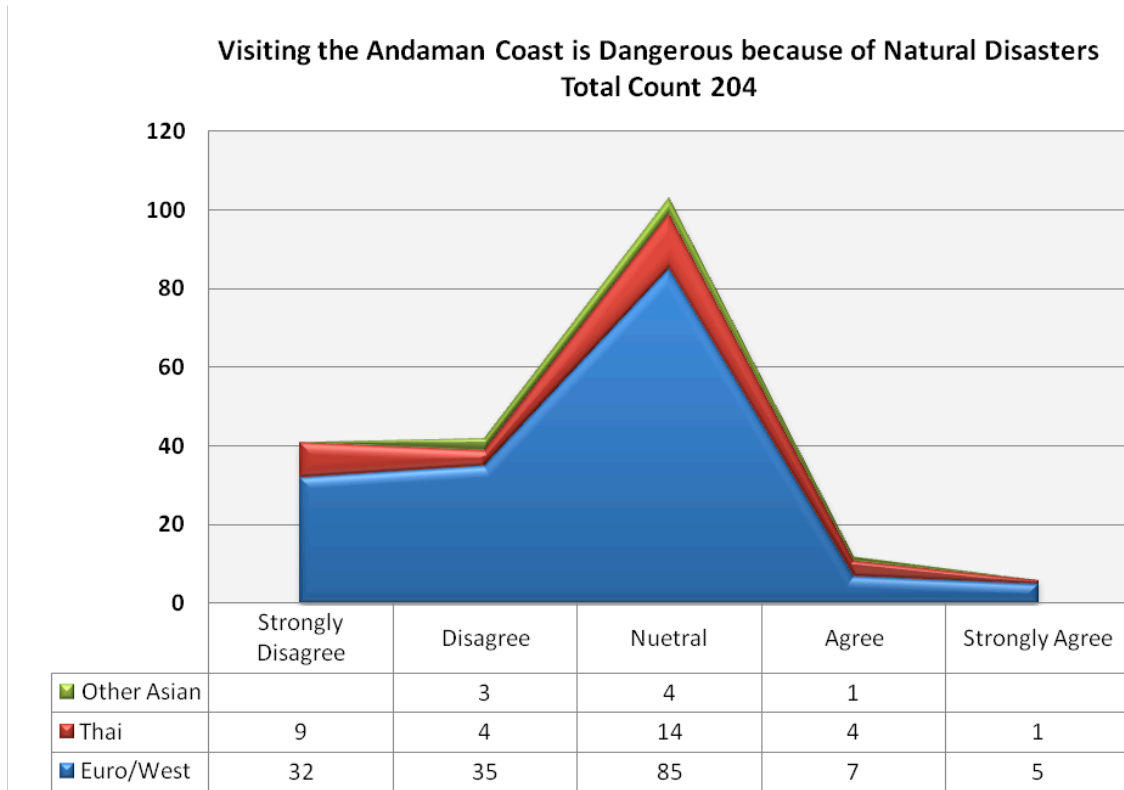
FIGURE 4

Knowledge of Tsunami and its Effect on Travel Plans by Nationality
Total Count 206



Respondents, likewise, did not attribute any specific or indistinct sense of danger with the broader Andaman Coast. When asked their position on the statement "Visiting the Andaman Coast of Thailand is potentially dangerous because of natural disasters," 50% of respondents cited their position as 'neutral'. As the graph below shows, there is an overall rise in those responding 'strongly disagree' to 'neutral' and a sharp decline in those responding that they 'agree' to 'strongly agree' that the Andaman Coast is dangerous. More than 91% of respondents stated that the Andaman Coast was either not dangerous or were neutral on the question.

FIGURE 5



Interestingly, when asked “On a scale of 1–5 (1 equaling ‘no threat’; 3 equaling ‘neutral’; and 5 equaling ‘high threat’) how would you rate the threat of natural disasters along the entire coast of Thailand?” 23% of foreign tourists recorded a value of 3.5–5. Yet, approximately 74% of these respondents recorded a value of 1–3, meaning that the majority of foreign tourists described the Andaman Coast as less dangerous than the entire coast of Thailand. As noted above, these responses were given at the same time that central Thailand and Bangkok were experiencing their worst flooding in half a century.

Thai tourists responded similarly to the above question with 44% describing the potential for natural disasters along the Andaman Coast as ‘neutral’. On a scale of 1–5, however, with 1 equaling ‘no threat’, 3 equaling ‘neutral’, and 5 equaling ‘high threat’, 90% of Thai tourists described the potential for natural disasters along the entire Thai coast as between 1–3 (33%, 27%, and 30% respectively), with approximately 60% describing the potential for natural disasters as ‘low’ to ‘no threat’.

4.3 Expert Analysis as a Periodic Attractor

As a cosmology episode, or a total upheaval in everyday life, the tsunami brought untold changes to the lives of those in Khao Lak. Understanding the catalyst(s) for the event was dependent on two key pieces of data: pictures/videos and eyewitness testimony. Videos provided researchers with data

from which they were able to calculate the acceleration of wavefronts as the tsunami reached shorelines. This acceleration has helped explain the ‘mesmerization’ of victims during tsunamis (SYNOLAKIS C. AND BERNARD E. 2006); appearing slow on the horizon, observers are led to a false sense of security regarding a tsunami’s speed. Once close to shore, though, the sudden acceleration of giant waves proves inescapable.

Eyewitness reports were able to provide information regarding wave height and direction. As a qualitative measurement, eyewitness testimony depends on an individual’s position in relation to incoming waves. Yet, several independent studies found that individuals who lived through the disaster gave accurate estimates of wave heights (THANAWOOD C. ET AL. 2006; SKELTON A. 2008; KARLSSON J. M. ET AL. 2009). The continuity between testimonies and the similarity in their estimates allowed for greater clarity regarding wave complexity, how far inland the inundation travelled, and the time interval between waves.

The engrossing media coverage, which quickly began to create the story of the tsunami and Khao Lak initially, relied on these key sources of data. Such data are crucial to any initial study of a crisis and speak to their evidentiary value in determining post-disaster quantitative measurements. What testimony provided which images alone could not was the context of ‘sets’; that is, the description of forces similar in size and shape coming at timed intervals. This information laid the groundwork for greater order through analysis.

Chaos theory holds that normally functioning states experience initial disturbances known as ‘bifurcations’ or the point where a system’s normal functions are interrupted. We can identify two principle bifurcation points, which occurred at Khao Lak on December 24th, 2004. The first bifurcation point came around 10am when dramatic changes to the predictable tides occurred, drawing water far out to sea. The second bifurcation point came roughly 26–29 minutes later with the arrival of the first tsunami wave and inundation from 0.5km-1.5km inland (KARLSSON J. ET AL. 2009). The first point is critical given Khao Lak’s shallow seabed, which made the retreat of seawater unnoticeable to some observers, and possibly lessened concerns, which would have likely been greater, had the water’s retreat been more dramatic. By the time of the second bifurcation point it is obvious from videos taken at Khao Lak that many locals and visitors did not appreciate the severity of the situation – that ‘mesmerization’ noted above – with many standing on or near the beach observing the incoming waves.

Sellnow (2002) notes that following bifurcation self-organization and the building of new structures and understanding often develop. Self-organization is the process whereby order re-emerges from inner principles rather than external factors. It is within the initial videos and testimony coming out of Khao Lak that order began to re-emerge as it was reformed into scientific and technical information by experts. Thus, while the potential for order came out of Khao Lak, that order was shaped through expert analysis as a periodic attractor.

Attractors arise within crises providing some degree of order amidst ongoing chaos (SELLNOW T., 2002). Periodic attractors constrain behavior to predictable patterns as they move from one extreme, through a midpoint, to another. Within social behavior this is reflected in individuals mustering determination and choosing one course of action before losing momentum and altering course.

Initial reports and videos of the tsunami presented scenes of total chaos, yet, these required scrutiny as to the cause of the disaster and what could be expected in the immediate future. As it was unlikely that new data would be emerge beyond known or expected geophysical, seismic, and oceanic

knowledge, incoming information was repeatedly measured against existing knowledge. This knowledge represented the parameters or those defined roles and values (THIÉTART R. AND FORGUES B., 1995) found within chaotic systems noted above. This created a clearer picture of events and the catalyst for the tsunami and, thus, a higher degree of order through awareness.

The extent to which this order reverberates over time is dependent on the degree to which that order is expressed and retained as a knowledge creating event. However, with widespread media coverage of natural disasters as they occur, the end of a crisis is difficult to determine. Repeated exposure, particularly through digital media, allows people to relive events, keeping their memory alive and a continuing part of local cultural identity. As of the writing of this paper in 2013, a simple search of cnn.com, bbc.com, and youtube.com with the phrase “2004 tsunami” yielded 82, 459, and 17,200 results, respectively.

Researchers in Norway found that threat intensity levels in survivors did not diminish over time but increased from 6 to 24 months following the event. A lack of improvement in post-traumatic stress disorder symptoms was associated with this increase but not with other factors including the degree of exposure to stress, personality, or social support (TROND H. ET AL., 2009). The United Nations Country Team, Thailand, in 2006, similarly, reported that thousands of adults and school children in Phang Nga Province continued to undergo psychiatric therapy up to a year and a half following the tsunami with 40 hospitalized for aggression or insomnia (UNTC, THAILAND 2006).

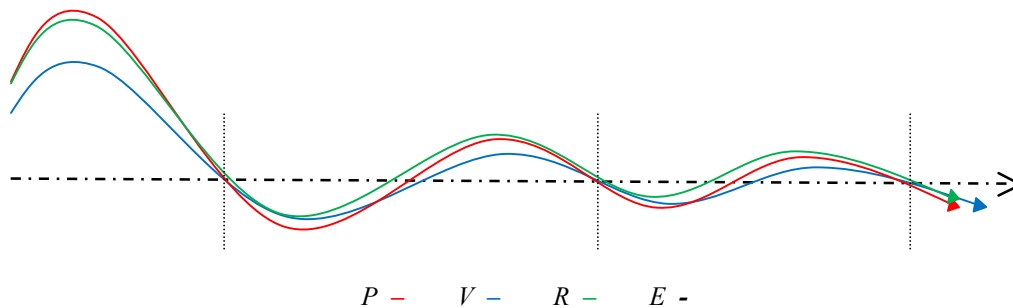
As the cultural imprint of a crisis retains a stronger presence within an affected community than outside of it, lessons learned from the event take the form of retrospective sense making. Although the likelihood of experiencing a similar event is rather low, the initial fear of a reoccurrence represents what Sunstein (1999) calls the “probability of neglect”. Sunstein (ibid) argues that when “emotions are intensely engaged, people’s attention is focused on the bad outcome itself, and they are inattentive to the fact that it is unlikely to occur.” Yet, as Weick (1995) notes, the issue is not that people need more information but more values, priorities, and clarity and less equivocality.

During crises, raw data, such as photos and videos come in quickly and often unedited as events unfold. However, at a certain point data will need clarification – a greater degree of order through analysis. Likewise, eyewitness reports alone provide only a partial picture, as they are dependent on an individual’s position relative to a crisis’ epicenter, although as noted eyewitness reports in Khao Lak have proven to be a reliable source of quantitative data regarding wave height.

The equation and diagram below are examples of how this clarity is realized over time. Let P (pictures), V (videos), and R (eyewitness reports) represent chaotic data symbolized by sine waves (data that comes in periodically as it is generated within a dynamical system) and E represent expert analysis.

$$E \ni (P \cap V) \cap R \Rightarrow P \square V \square R = \Delta(1/x + 1)\sin(x)$$

FIGURE 6



Over time the chaotic nature of data from the system will be clarified by expert analysis acting as an attractor bringing about a degree of order within the system. As time progresses and greater amounts of data are generated, more order is created given that testimony and imagery will provide a fuller account of the dynamical system but not necessarily provide information that is beyond the scope of that already received. The tsunami waves did not go on in perpetuity but had limited duration. New imagery and testimony would, therefore, be of the same waves albeit perhaps from different perspectives. In the above diagram *P*, *V*, and *R* would eventually taper off, growing incrementally closer to *E* given that with more data from the system expert analysis provides more order over time, not less.

Stewart and Ueda (2013) state that “The most severe catastrophic bifurcation is the total loss of stability of an attractor, so that when it is stepped from μ_l to μ_{l+1} , the system experiences a transient jump followed by settling to another attractor, whose location in phase space is remote from the attractor sustained at $\mu = \mu_l$.” The above diagram depicts one attractor in one setting (Khao Lak) but in reality multiple attractors – i.e. multiple experts – would be providing analyses in multiple settings. An example of attractors losing stability in this scenario would be information coming in from another area hit by the tsunami – Sri Lanka, Indonesia, and so on. Yet, as analysis from within or in reference to this new data is applied to the broader system, order can remerge.

The large amount of information collected from pictures, videos, and eyewitness testimony provided experts with firsthand data through which they were able to relate critical news, in some cases as events unfolded. This has produced vital information for research institutes, universities, and communities at risk for tsunamis, while providing survivors of the event with explanations as to the processes of what happened and why. This is a far different situation from before the tsunami where the lack of response by those caught up in the event along with the absence of safety measures demonstrated that the lessons from previous tsunamis had not been widely disseminated (WEICK K., 1995).

Two related studies provide insight into expert analysis acting as a periodic attractor. In a survey of 604 Hong Kong residents who saw tsunami footage >10 times per day, 52.6% - 67.4% of respondents reported experiencing severe to very severe levels of stress; 30% - 39.5% of males and females respectively experienced mild PTSD symptoms while 5.9% - 8.7% experienced moderate to

severe PTSD symptoms (LAU J. ET AL. 2006). However, a survey of 209 women in the Indian state of Tamil Nadu found that media presentations of scientific and technical information regarding tsunamis helped educate women of tsunami risk factors and the need for compliance with tsunami warnings (SRI JOTHI P. AND NEELAMALAR M. 2011).

The Hong Kong survey would appear to contradict the thesis under consideration in this study while the one from Tamil Nadu supports it. The differences are likely the result of three principle factors: 1) those who lived through the disaster as opposed to those who witnessed it via media outlets; 2) the level of analysis presented to each group; 3) socioeconomic and cultural differences related to perceptions of the supernatural.

The first factor is likely the most significant as those who lived through the tsunami were still coping with its effects such as the loss of loved ones, housing, and agricultural land. Explanations of the causes and assurances that a similar event would not occur without comparable catalysts did much to alleviate concerns for individuals in such an agitated state. This relates to the second factor. The Hong Kong study is silent on the quality of exposure respondents experienced; that is, whether the vivid images were coupled with concomitant analysis. It states that "Media coverage, in terms of frequency of coverage, visual images, and distressful contents was a strong predictor of stressful responses related to the tsunami," (LAU J. ET AL., 2006) but does not elaborate on whether additional analysis played a role in respondents' stress levels.

In terms of socioeconomic and cultural differences, 40.1% of the Hong Kong respondents reported some post-secondary education while perceptions that disasters were the result of God's punishment were noted by researchers to be associated with mental health outcomes. The Tamil Nadu study, on the other hand, was conducted among individuals for whom "socio-economic conditions were generally low along with a very low literacy rate," while most were semi-literate (SRI JOTHI P. AND NEELAMALAR M., 2011). Although Sri Jothi and Neelamalar do not comment on beliefs related to supernatural causes of natural disasters, they did note that media attention increased awareness of tsunami risk factors and warnings as well as subsequent social problems such as teen marriages, prostitution, and alcohol abuse along with sanitation and hygiene issues. These proved particularly important given that many of the women in the study had lost their husbands and/or sons making them the head of their households and primary breadwinners.

Whereas the respondents in the Indian study had to contend with real-world rehabilitation and social concerns amid tragic loss, those from Hong Kong contended with repeated imagery. Although the Hong Kong respondents experienced stress through viewing these images, it was likely far less than the Indian respondents who lived through the tsunami. Without sufficient data as to the amount of analysis Hong Kong respondents experienced we are left with the conclusion that the frequency of viewing distressful content and images increased fears for those reporting PTSD symptoms, while the conclusive data from the Indian respondents demonstrate that extended analysis and technical information were crucial in reducing fears.

4.4 Internal and External Events

Political and economic events alongside other natural disasters grabbed headlines and focused attention away from Khao Lak at the same time it was making a recovery while its loyal following

among many foreign tourists helped speed its reconstruction. As noted in Section 3 these events include the 2006 coup in Thailand, the global economic slowdown in 2008, the 2009/2010 'red shirt' demonstrations, the election of Thailand's first female prime minister, the military conflict with Cambodia, and the extensive flooding of the capital and central Thailand in 2011.

It is reasonable to assume that attention regarding the tsunami diminished at least after 2006, the same year that Prime Minister Thaksin Shinawatra was overthrown in a military coup. The global economic recession in 2008 was also a determining factor, which affected reconstruction efforts and was cited by tourists and business owners alike as influencing travel to Khao Lak. Likewise, the election of Thailand's first female prime minister (and sister of the man who was overthrown in a military coup, no less), historical border issues with Cambodia, and flooding which hurt two key sectors of Thailand's economy – tourism and manufacturing – affected much larger segments of the population than the tsunami alone. Taken alongside Khao Lak's recovery, the broader effects of these more recent disasters and political/social disruptions may be more pronounced than the legacy of the 2004 tsunami in the future.

There have been other factors that have likely helped reduce anxieties over time, particularly in the areas directly affected by the disaster. Since the tsunami programs such as the FAST (Families and Survivors of Tsunamis) Project in Indonesia, Sri Lanka, and Thailand along with TARNs (Tsunami Alert Rapid Notification System) for Thailand, part of the Indian Ocean Tsunami Warning System, have been employed in an effort to increase awareness throughout the region. These and other programs have produced a greater understanding of the nature of tsunamis, the catalysts for them, and what to do in the event of a tsunami warning and have likely contributed to the overall abatement in fear in the months and years following the disaster. When taken as a whole, the role of expert analysis of earthquake generated tsunamis played a significant role in reducing anxieties related to their causes, while the impact of events within and without Thailand shifted media coverage away from the disaster and reconstruction efforts in the years that followed.

5. CONCLUSION

The 2004 Indian Ocean Tsunami was one of the greatest natural disasters in human history taking the lives of hundreds of thousands of people worldwide. Of these, more than 5,300 died in Thailand with the majority dying in or around Khao Lak. Overall damage from the disaster cost Thailand more than 510 million US dollars. Today, hotels have returned and the tsunami for many is a thing of the past. While it will always be part of Khao Lak it has not been the end of the town by any means.

When viewed through the perspective of chaos theory, the tsunami presented a scenario that quickly brought disorder and confusion to the lives of participants. Video and eyewitness evidence demonstrate that individuals became quickly overwhelmed as a cosmology episode unfolded, dashing any sense of normalcy that existed prior to the initial earthquake.

Yet, videos and eyewitness testimony also revealed that order could be found even in the midst of chaos. As information came in from disaster zones it was reconciled against the technical analysis provided by experts. As a periodic attractor, expert analysis acted as a fulcrum around which information from the field was constantly referred. Thus, videos and eyewitness accounts did not splinter off or stand apart but were constantly checked against objective scientific scrutiny providing clarity in the midst of chaos and a greater degree of order.

This analysis has been instrumental in alleviating anxieties of those who lived through the disaster, and from interviews of tourists and local Thais it has been integral in creating a greater degree of awareness and understanding of earthquake-generated tsunamis. Within this study respondents were not only very knowledgeable about the event but that knowledge did not have an adverse effect on their decision to visit Khao Lak. Indeed, the more individuals knew of the disaster the less it affected their travel plans. This supports the inference that the more a seemingly unknowable event is made understandable, the less anxiety individuals experience in reference to it.

Given that the majority of foreign and Thai tourists surveyed were first time visitors who travelled to the area specifically for its remote and quiet atmosphere, it is apparent from this study that fears of recurrent disasters are not as controlling as they once were. Instead, more everyday issues such as cost and travel time appear to be the principal issues tourists consider before visiting the area. Yet, the vast amount of data created in the wake of the disaster has lived on via the Internet meaning that the tsunami and lessons learned from it are available to a wider audience. Among the respondents surveyed in this study this has not increased Khao Lak's connection to the event but instead reflects a broader knowledge of the tsunami coupled with lower levels of anxiety in reference to it.

The seven years between the disaster and this study in all likelihood played a significant role in reducing anxiety levels. However, when viewed in its entirety what is seen is a crisis event turning into a learning event. The low anxiety levels coupled with the high levels of knowledge of the tsunami and the lack of negative effects the tsunami's legacy has had on travel plans as reported by the majority of respondents point to the impact of expert and technical analysis with defined values, i.e. periodic attractors. Random newsfeeds gave way to informed and measured reports by experts explaining what for most is a mysterious and once in a lifetime event. Thus, it appears to be the case regarding the 2004 tsunami that the more an otherwise enigmatic threat is made understandable, the less it is seen as a threat or at least as something that should be viewed as a credible threat.

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