The International Emergency Management Society
9th Annual Conference Proceedings
University of Waterloo, Canada, May 14-17, 2002

RESILIENCE AND REALITY– THE WORLD TRADE CENTRE NEW YORK 11.09.2001

Dr. Robert Heath

International Graduate School of Management, University of South Australia[1]

Keywords: World Trade Center, resilience, terrorism, response management

Abstract:

The terrorist attack on the World Trade Center on September 11, 2001, resulted in the total loss of the two towers and surrounding buildings, with an uncertain number of dead (conservatively over 2,000). Media commentators claim this event changed the world as we knew it.

Ability to cope with change is a factor in level of resilience (Paton, Johnston, Smith, & Millar , 2001). Humans seem to elicit resilience from social bonds, skills, social norms, and perceived self-efficacy (resources (Buckle, Mars & Smale, 2000; Lindell & Whitney, 2000). This suggests that broad clusters of activities may lead to improved understanding of how these factors promote resilience, and absence or low levels of such factors lead to vulnerability and, perhaps, worse impact damage and long recovery periods.

This paper points out that the change may be through perceptions rather than a manifest change – public perceptions of security and invulnerability were shaken if not fractured. Impacts included major disruption to American and world aircraft movements, evacuation of buildings, closure of the New York Stock Exchange, American and global nervousness in share trading, and financial pressures on many airlines. More fundamental and long-term effects included the fall of the Taliban government in Afghanistan, a declared war on terrorism by America and allies, and a suggested annual cost to the US of $151 billion.

Discussion covers entry of first responders and strategic command, risk manage, site management of adjacent areas, return to work messages, security, the focus on Osama bin Laden and Al Qaeda, and vulnerability. These raise questions over conditions for site entry, escalation to "worst case" responses, oversight of other causes and issues, and public beliefs and readiness. The paper concludes with an outline of how resilience can be sustained and improved by attending to psychological as well as physical resilience, and by further attending to public beliefs as well as response agency readiness and to our ability to manage and provide resources for response and recovery activities as well as improving structural strength and integrity.

[1] Way Lee Building, Campus West, North Terrace, Adelaide 5000, Australia.
Telephone: +61 (0)8 8302 0905 Email: rjheath@compuserve.com

1. Introduction

Commentators claim that the world as we knew it changed when two passenger-carrying aircraft were hijacked and deliberately crashed into the World Trade Center (WTC) at 8.45 AM and 9.06 AM respectively with the consequent complete destruction of both towers and several adjacent buildings. This is not quite true. What may have changed was the *perceived nature of risk and threat held by the public at large and maybe by many media commentators* – the threats and risks were (and are) the same before this event and after this event.

This is true for the WTC as an attempt to topple one tower on to the other failed only in its execution in 1993.

2. Resilience

A key factor in dealing with sudden disasters (including terrorist attacks) is that of resilience. Resilience can be defined as the degree to which an impacted resource or organization may resist impact damage and the speed with which that organization recovers or that resource can be recovered. Elements that support resilience include shared values, established social infrastructure, sustainability of social and economic life, presence of partnerships, presence of networks, and the degree of developed skills and available resources (Buckle, Mars & Smale 2000). The rule-of-thumb here is that resilience positively correlates with the number of bonds and the size of skill pools and resources in hand that are appropriate to countering a sudden impact.

Paton, Johnston, Smith, & Millar (2001) provide a more flexible definition in terms of systems. They see resilience as "the capacity of systems to maintain their integrity and the relationships and balance between elements in the presence of significant disturbances by drawing upon internal resources and competencies to manage the demands, challenges and changes encountered" (p, 47). This reflects the combinative factors of resistance to impact ("maintain their integrity") and rebound or recovery speed ("drawing upon internal resources … to manage the demands, challenges and changes encountered").

Levels of individual resilience, on the other hand, may reflect varying degrees of self efficacy (Lindell & Whitney, 2000). One means of increased resilience emerges from focussing on coping with problems (Bachrach & Zautra, 1985). Theories, including Planned Behaviour (Ajzen, 1991), and models, including the Person-Relative-to-Event (Duval & Mulilis, 1999) attempt to link individual and social or community or organizational perceptions into predictive efforts in the adoption of risk reduction behaviours. This is felt to increase resilience. The focus falls on motivation to act coming from perceived threats, and considers self-efficacy, social norms, past experience, and outcome expectation expectancies.

Factors affecting and indicating resilience can be considered within the context of the World Trade Center event of 11t^{h} of September, 2001.

3. The World Trade Center Bombing – 09.11.2001

Sometime after take-off from Boston at 7.58 a.m., Los Angeles bound United Airlines Boeing 767 (Flight 175) was hijacked. Similar hijackings happened to American airlines Boeing 767 Flight 11 (Boston to Los Angeles) at 7.59 a.m., United Airlines Boeing 757 Flight 93 (Newark to San Francisco) at 8.01 a.m., and at 8.10 a.m. for American Airlines Boeing 757 Flight 77 (Washington to Los Angeles). In less than three hours all four had crashed. At 8.45 a.m., Flight 11 with 92 passengers and crew was crashed into the North Tower WTC. At 9.03 a.m., Flight 175, carrying 65 passengers and crew was crashed into the South Tower WTC. At 9.38 a.m., Flight 77, holding 64 passengers and crew, was crashed onto the northwest side of the Pentagon in Washington. Finally at 10.37 a.m., Flight 93, containing 45 passengers and crew, crashed relatively harmlessly outside

Pittsburgh (possibly due to passenger action). The South Tower WTC collapsed at 10.00 a.m., followed by a collapse at 10.29 a.m. of the North Tower WTC. The outcome was "the bloodiest day on American soil since our Civil War" (Time, Special Issue, 12.09.2001).

The terrorists selected the quietest day of the air traffic week, which meant they accessed fully fuelled-up passenger jets with low passenger numbers.

Some facts about the WTC

North Tower: 110 floors, 97 passenger and 6 freight elevators, 200 feet (around 60 meters) square, 1,368 feet (around 410 meters) height, completed in 1970.

South Tower: 110 floors, 97 passenger and 6 freight elevators, 200 feet (around 60 meters) square, 1,362 feet (around 408 meters) height, completed in 1972.

Total occupancy was around 50,000 capacity plus visitors and tourists. Each has a mass of around 500,000 tons.

The heat of fires from the fuel of the jets contributed to the collapse by altering the chemical structure of steel (softening) resulting in the above-crash weight of the building leveling the below-crash floors in a chain reaction. Added to this can be probable loss of structural integrity from the aircraft frame bending or severing central core supports, central lift wells and steps spaces acting as flame concentrating torches (see Kings Cross London Underground fire and a number of high rise fire findings), and possible floor truss and floor support-fixing failures. Several other buildings collapsed (the World Trade Center) or became collateral damage from debris and the collapse (including the Marriott Hotel). The South Tower, although struck after the North Tower, eighteen minutes later, collapsed almost half an hour before the North Tower, probably because the aircraft impact was around twice as low down the building (75^{th} as opposed to 95^{th}) and thus the far greater weight made structural failure occur at a faster rate.

Witness and preliminary investigation reports tend to suggest the situation was non-survivable from those above the midpoint impact areas as fire escapes would have been either obstructed or coated with burning fuels.

4. Impacts – immediate and short term

1. Cessation of aircraft traffic in the United States.
2. Gridlock and shutdown of central New York (central and lower Manhattan) and of Washington as both an outcome from the Pentagon strike and the WTC effort.
3. Cessation of trading in the New York Stock Exchange. This cessation stretched over a few days, as did specific market trading areas. Note that one major player in this form of market lost nearly all of the US half of their workforce.
4. Evacuation and/or closure of many public buildings including – the White House, Capitol, Pentagon, United Nations building, Sears Tower (Chicago), L&C Tower (Nashville), John Hancock Tower (Boston), Disney Parks (Florida, California), major league base-ball games and sites, Hoover Dam, the Space Needle (Seattle), Mall of America (Minnesota), Kennedy Space Center, bridges and tunnels into Manhattan (by 9.35 a.m.), museums and monuments in Washington, and most significant structures owned or leased by federal and state governments.
5. A drain on motor vehicle fuel reserves across the US as motorists took emergency precautions.
6. US and global nervousness and climate became such that subsequent evacuations of significant buildings arose around the world and terror by germ warfare via postal services arose in US. This latter fear was reflected in false scare campaigns in countries like Australia. In one sense

the terror campaign succeeded in creating a nervous and apprehensive reaction, particularly in some areas of the US.

5. Impacts -- Middle and Long Term

Longer lasting impacts, outcomes and consequences included:

1. There occurred a local (North American) and world recession in tourist travel. Again, when issues of shattered expectancies and minimal past experiences are considered (as per Ajzen, 1991; Duval & Mulilis, 1999) at least partial explanations emerge for the tardiness of recovery of passenger numbers on aircraft. People still express concerns about flying some six months after the event, particularly within the United States.
2. Uncertainty in stock market values and trading (around the world) combined with an ongoing "fear" of recessional economic environment and a situation-consequent uncertainty over US (and world responses) and terrorist next actions to produce an unsettled and "flat" share and bond market activity.
3. Airlines faced insolvency and increased business costs due to longer throughput hours and security checks – this can indicate a move toward local rather than global business supply chains. September 11 effects may combine with ongoing internal problems to terminate United Airlines (similarly as the Locherbie (PanAm 103) bombing may well have assisted Pan Am into termination). Here, adjustment to risk establishes a slower more detailed set of activities in terms of security checks and monitoring. This may ease as the sharpness of the experience fades and any ongoing and visible consequent events fail to arise.
4. There appeared to be a hiatus to Just-In-Time systems approaches, with a need to stockpile for (1) slower deliver/access times and (2) meet just-in-case needs. Modifications in this strategy may lead to a more permanent adaptation that seeks an optimal balance of just-in-time methodologies with a just-n-case storage process.
5. The Taliban Government in Afghanistan fell to Afghanistan and US-led military forces.
6. American political and civil groups have developed a more confrontive style of interaction.
7. Economic costs for continued trading may be large and thus add to recession concerns. Fortune Magazine (February 18 2002, 145 (4), pp. 6267) estimates an annual potential cost of US$151 billion in transportation, and employee.

   There can be some argument over these figures in terms of (1) size and scale, (2) frame adjustment and (3) factoring in one-off and recoverable costs. Size and scale may be initially high but reduce over time as one-off costs and cost recovery reduce the impact and as inertia prevails with no onset of any successive equivalently sized impacts. One can argue that the prevailing expenditure prior to September 11 was wrong or even negligent and the current state of cost and effort is the real cost of doing business. After all, the actual threat of terrorist behaviour and size of effort involved was present before and after this date (as is directly evidenced by the relatively aborted 1993 WTC bombing). Finally there are blurred estimates that include potentially irregular or even one-off costs (IT hardware for back-up) and process costs (such as delays, logistics, and transportation). While the process costs are increased, these are likely to be the same across competing organizations and can or will be passed on through to end users and customers.

6. Observation and Comments

1. ***Entry of first responders***. This is somewhat of an emotional and an article of public canon – emergency responders were and are heroes. There are aspects of this situation entry, however, which need consideration. At a primary level what was the clear or hard information held by first responders? Bluntly speaking (without subsequent investigative hindsight) a modern large commercial aircraft, laden with fuel, crashing at speed into a building will destroy the impact area by fire alone – and will, by the very nature of the structure of a high-rise tower complex, destroy the tower. Should there be clear awareness of this information at the time and on the site, then there exists a question as to whether site entry was appropriate for more than those assisting the evacuation of the below-impact portion of the tower. Were the responders placed at risk in this situation? Movement towards impact sites may appear to be a questionable practice, given:
   - the area size of each floor (40,000 square feet or over 3900 square meters),
   - the vertical impact damage of between six and nine floors,
   - the high probability of burning fuel draining down the liftwells in the center section and acting as a flue "torch" (or piped fire) element that would spread the fire (increase temperature and precipitate soft steel deformation and structural collapse), and,
   - two hose teams may effectively cope with around an eighth of a floor area.

   Balanced against this can be unclear information about cause and thus likely scale of situation, the action ethos of emergency service personnel (particularly the aggressive get-to-the-seat-of-the-fire response by most US firefighters), the impulse to help those in danger, and a need to be seen to be doing something.

2. ***Entry of strategic command***. The above comments apply equally well to strategic management attendance, again with the need to balance the standard operating procedures against specific situations. Bottom and tactical level of management goes where the coalface response teams. One could be more critical of higher level management placing themselves and their staff at risk (and, indeed, the overly close proximity of the New York crisis management response, from the Mayor down). Reasons for close proximity may include the perceived need to sense and see the site, lack of alternate and readily accessible locations, and the mental impact of the size and nature of the incident. There probably was an underestimate or lack of recognition of the possible (and actual) consequences and thus an underestimate of threat and risk of danger. Given contemporary audiovisual and computer systems we may need to further rethink and refine line-of-command location and activity. Here again we may consider that the size of the structures and a lack of actual experience with this size of situation can lead to possible defects in current zones of operation and positioning.

3. ***Site management of adjacent area***. Probably the comments addressed n the above two points are equally applicable here. Some thought may need to be given to create greater sterile zones earlier in the situation management process to move those in debris line-of-fire to greater safety and restrain encroachment by spectators. In the WTC situation (and others in the future) this would form part of the "Worst Case".

4. ***Risk / threat is greater than conventional perception***. Conventional business continuity, crisis and contingency management practices have perhaps poorly developed worst case scenarios for a preferred more likely case or set of cases based on likely frequency of occurrence. Take heed of the staff and resource loss that faced Morgan Stanley Dean Witter, with 21 floors of South Tower, or Port Authority (6 floors) and Cantor Fitzgerald Securities (six floors) in North Tower. We need either to avoid such concentrations in number of staff onsite or to ensure that our risk management covers these exposures.

5. ***South Tower message to return to work***. Note the confusion and implications of the reported "return to work" announcements made within the South Tower complex. To an extent this met

the perceived situation prior to the South Tower attack, but may not have fully apprehended risks in terms of damage from the North Tower or vulnerability to attack – and thus leaving open potential "duty of career" litigation.

6. ***Security***. For parts of the world less troubled with terrorism, the WTC may well have been somewhat of a wake-up moment. Two things need to be noted:
   - The outcome was in the hands of the terrorists once airport security was breached. Moreover, standing air patrols of fighters serve really as visible images of doing something and possible re-assurance, and as a small deterrent – what serving pilot or government can afford to shoot down a passenger aircraft loaded with their own nationals over densely populated ground.
   - Heightened security will relax over time and vigilance decrease unless further major incidents arise. This will particularly apply when current states of vigilance impede easy flow of business (what is being called "friction", as per Fortune Magazine).

   On the other hand, tightened security can reduce pilfering, insider crime, lost resources, and lead to efficiencies in system management and inflows and outflows of goods. While these do not show up as cash benefits in the security budget, it is worth undertaking a realistic guesstimate.

7. ***Security – Airport and aircraft***. Most airports and airlines try to balance people movement with security measures. The current balance is currently tipped heavily in favour of security, with longer time lags to get from airport entrance to aircraft – the current average lag in February 2002 is one hour extra at large US airports.

   ElAl has the highest physical security, but is relatively speaking a low-volume airline. Larger world airlines, already struggling financially due to competition and the WTC incident, are likely to press eventually for ways in which to speed up passenger throughput. Perhaps the two key areas for increased security surround access to the cockpit crew (locked doors, penetration-proofing of doors) and cabin security. Sky marshals were increased in the US and introduced in Australia. On a tangent, the WTC has increased interest in bomb-resistant containers for aircraft. Increased security has led to further curbs on potentially lethal sharp objects (scissors, pocket knives, metal knives and forks) which may be a little draconian given the limited multiple damage done at one time by one of these, the utility of these for passengers (and in emergencies), and the doubts that were subsequently placed on reports that similar items (including carpet cutters) were used in the WTC aircraft highjackings.

8. ***Focus on Osama bin Laden***. The US government had to walk a fine line between public disclosure and confidentiality for investigation and response purposes. One possible problem in this effort emerges from the real media and public pressures for culprit identification. The key planner was alleged to be Osama bin Laden supported by the Al Qaeda terrorism unit. From time to time governments have released supporting information. However, coupled with an historic cynicism over governments not releasing full information or even doctoring information to suit their needs, is a growing public awareness that many of the early arrests have ended with those arrested being released due to insufficient information or no substantiating evidence at all.

   The central figure and the existing terrorist structure have been disbanded and destroyed by US-led operations around the world, particularly in Afghanistan where the Taliban government was toppled.

9. ***Accent on patriotism – unity and anger***. In many crisis situations two emotions generally emerge – a sense of unity ("us" versus "them") and one of anger (and even a search for a scapegoat). Both forms emerged around the world – remembering that many countries lost

citizens in the incident. The sense of unity led to an increase in felt and visible unity in the US where a publicly-held belief of being distanced from terrorism seems to have been severely shaken. This pre-WTC public belief may seem surprising given the visible effort the FBI has placed on managing chemical weapons of mass destruction, the previous WTC incident in 1993, the Oklahoma City bombing, and other significant disturbances from Waco through to the riots surrounding the court findings over the Rodney King beating in Los Angeles).

As arose in Oklahoma City after the Murragh Building bombing, the sense of unity was very visible among response agencies and among New York residents. Volunteers came from within the city and from across the US.

Anger also leads to scapegoating and undoubtedly contributed to hate-crimes against those with Islamic faith in most countries. Even allowing a ten-fold increase on reported incidents in the US of hate-crime directed at those of apparent Arabic cultures and physical structures associated with Islamic belief, the figure was surprisingly low.

10. ***National psyche – a more vulnerable US***. Perhaps the clearest impact may have arisen within the public belief (or psyche) of Americans. Lack of apprehended threat, perceived economic and military size, and cultural characteristics of individualism and ease of access may have contributed to a sense of invulnerability that has been shaken. Many reports suggest a more inward looking tendency and measures of travel volume and work absence tend to support this increased sense of vulnerability. Some businesses report a need to encourage commercial travel through buddy systems and increased payments.

    Loss of belief certainties and thus an increase in feelings of vulnerability take time and absence of incident to heal. In many ways this loss can be equated to the feelings held by those experiencing their first earthquake, wildfire, "flash" flood, or tornado. Confidence, like reputation, is slowly learned but quickly lost if the loss experience creates doubt over the validity of the belief. These indicate qualitative agreement with research findings (Duvall & Mulilis, 1999; Bachrach & Zautra, 1985) where concepts of expectations and past experiences fail the situation – the US public did not generally expect such a large terrorist event to arise within their community and had minimal past experience upon which to draw.

7. Vulnerability

The WTC event reinforces the need for appropriate risk assessment of risks and of perceived vulnerabilities, with corrective actions being taken when one is not in synchronization with the other. Vulnerabilities that are not addressed by the appropriate business or government management authority will act as a public cancer over time. Risks that exceed publicly-held perceptions of vulnerability need to be managed so decrease the risks and increase public awareness, as any subsequent manifestation of the risk event is likely to shock or even traumatize the unsuspecting population.

8. Resilience

Moving from the factors and thinking outlined by many researchers and theorists (Azjen, 1991; Duval & Mulilis, 1999; Lindell, & Whitney, 2000; Paton, Johnston, Smith, & Millar, 2001) resilience may be viewed as a composite of a number of factors. This composite may be defined in broad groupings that focus on psychological and physical or tangible clusters of factors.

Community and organizational resilience thus can be considered in terms of psychological and physical components. Each of these divides into at least two parts. Psychological resilience, for example, can be seen as a composite of preparedness and group or community beliefs. Physical resilience can be seen as a composite of ability to withstand impacts from the situation and ability

to repair and regenerate.

Preparedness stems mostly from core team (responder) training and skill levels and from management planning and support. Across communities and organizations, preparedness tends to be more passive, being based on videos, warnings, and instructions on basic things to do and who to contact. Real preparedness is tested only by encountering a situation. Overall, preparedness diminishes with accent on other priorities that have more immediate outcomes and consequences and lack of precipitating situations.

Community and across organizational beliefs shape the perceptions held by the members of that community or organization. While the size and strength of the belief may vary according to sub-groups within that community or organization, the overall prevailing attitudes and perceptions condition the overall response to impacts. Fractures in these public beliefs can lead to suspension of belief and action, depending on the response capability of those in the preparedness activity. In the WTC case, this was high across the New York City management and response agencies – even after sustaining many casualties from the first responders and their immediate support teams.

Where preparedness within the core team is high the beliefs of the population are fractured the population can impede through disbelief and unwillingness to act. This did not arise in the WTC situation as the situation was relatively localized and nonsurvivable by those trapped in the above impact levels of both towers. On the other hand greater levels of area evacuation and street control may have been possible during the one and a half hours before each tower collapsed had this possibility (belief) been in place.

Where preparedness is low and beliefs are fractured, response can appear random and sluggish and frustration, anger, followed by hopelessness and even learned helplessness develop among the population over time.

Given low preparedness but significant appropriate beliefs then effective response may emerge from volunteer or population efforts. This form of outcome is also visible in situations where the size of the situation exceeds the response efforts (so that overall response appears dispersed or patchy) and people help themselves. Data gathered from the Northridge Earthquake, for example, suggest that between 80 and 90 percent of rescues of trapped people being undertaken by non-response agency personnel.

High preparedness and highly appropriate beliefs obviously indicate an optimal perhaps target or ideal level of resilience.

From the physical half of resilience, "hardened" situation-designed structures directly reduce impact damage and threat to people. Successful strategies here generally follow one or more of the ABC Model – Build Away, Build Better (stronger, more resilient), Build Compatible. By creating immediate physical resilience we reduce costs and can concentrate the core response personnel and resources at specific situation-caused hotpoints. In the WTC situation, the area and the two towers were not generally hardened against terrorist activity or specifically hardened against modern aircraft impact damage. Underscoring this is the question of how well structures and people can be "hardened" – although pointers can be learned from those regions in the world that endure relatively frequent levels of terrorist or other crisis situations

The other half of physical resilience is our ability to physically manage the impacts and recover the situation to some acceptable level of functioning. Here, undoubtedly, strong economic and industrial resources add to resilience – as can be evidenced by the speed with which San Francisco and Kobe recovered from infrastructurally damaging earthquakes and the relative efficient and quick clean-up at the WTC site.

High structural resilience built into the environment and sufficient to excess response and recovery

resources provides target and ideal levels of sustainability and resilience. The opposite (low structural resilience and low availability of response and recovery resources) suggest a slow response with increasing consequential impact damage and a slow and enervating recovery. High structural resilience combined with low resource availability suggests reduced or localized damage that may not be quickly recovered (which may within those localities enervate resilience). Low structural resilience combined with high resource availability suggests a broad immediate damage followed by relatively quick clean-up and fast recovery probably focused on core components of an organization or community. Aspects of Kobe's recovery suggest that this can be seen as an example of this last combination.

The picture painted here may suggest that resilience need only be built upon the response and post-response efforts. Look again. Psychological resilience is built on being prepared and holding appropriate beliefs. The strength of these depends on the effort we put into them before a response and that effort needs to cover reducing exposure to risk and thus vulnerability. This can be seen even more clearly when we look at physical resilience. Here, we need to create structures that resist adverse situations – and thus are resilient. Crisis management comes into play when we cannot reduce or eliminate risks. By having sufficient and appropriate resources in hand we can reduce the time taken to clean-up and time spent in recovery mode. This quick recovery promotes resilience.

9. Conclusion

The total loss of the World Trade center and surrounding buildings had a very visible and salient impact. Alongside the loss of life, the management of removing a million tons of rubble, and the need for hundreds of businesses to use extreme business recovery approaches, this event has had economic and operational repercussions within the US and in other parts of the world. Increased security, for example, has meant slower business interactions, longer travel delays, and a range of commercial and access frictions. The impact on the world has included the fall of the government in Afghanistan, changes in international political posturing, and a decline in air travel and tourism.

As suggested in the brief overview of factors contributing and defining resilience, individual preparedness and community bonds help overcome impact damage. Certainly this is evident in the community responses within the Manhattan and New York region in helping each other and demonstrating respect and care for those impacted by the event and for those who handled the response and who are continuing the recovery activities. Certainly the speediness with which the destroyed overburden has been removed demonstrates a visible factor of resilience.

The reported heightened security and sense of vulnerability may decay over time – provided there arise no equally visible and salient events. Investigators and researchers explore why the towers collapsed so quickly, the fractures in the social and cultural beliefs (particularly in the US), and the management of large emergency events in urban environments. From these efforts can emerge greater awareness of the need to focus on building and maintaining communities and regions in which people are not only protected but also able to cope with emergency situations. By doing this we move further into developing sustainable and resilient urban communities.

References

Azjen, I. (1991). *The theory of planned behaviour*. **Organizational Behaviour and Human Decision Processes**, 50, pp. 179-211.

Bachrach, K. M., & Zautra, A. J. (1985). *Coping with a community stressor: The threat of a hazard waste facility*. **Journal of Health and Social Behaviour**, 26, pp.127-41.

Buckle, P., Mars, G., & Smale, S. (2000). *New approaches to assessing vulnerability and resilience*. **The Australian Journal of Emergency Management**, 15 (2), pp 8-14.

Duval, T. S., & Mulilis, J. P. (1999). *A Person-Relative-to-Event Approach to Negative Threat Appeals and Earthquake Preparedness: A Field St*udy. **Journal of Applied Social Psychology**, 29, 495-516.

Lindell, M. K., and Whitney, D. J. (2000). *Correlates of household seismic hazard adjustment adoption*. **Risk Analysis**, **20**, pp. 13-25.

Paton, D., Johnston, D., Smith, L., & Millar, M. (2001). *Responding to hazard effects: Promoting resilience and adjustment adoption*. **The Australian Journal of Emergency Management**, 16(1), pp. 47-52.

Author Biography

Dr Robert Heath is Associate Professor (Strategic Risk Management) in the International Graduate School of Management, University of South Australia and also consults in international crisis management and business continuity.