How people behave in anticipation of and during earthquakes: A review of social science literature on what drives this behaviour

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ABSTRACT :

The paper reviews social science research on what motivates people's behaviours in anticipation of and during earthquakes. Seismic risk perceptions vary according to psychological, social and environmental factors, but do not directly determine seismic adjustment. Risk perception motivates people to assess their subjective sense of control over earthquake risk. Levels of control are further moderated by sociocultural norms regarding who is responsible for seismic adjustments. Without trust in one's own and others' competence and willingness to reduce earthquake exposure, adjustment intentions are weak. Acting on credible warnings is conditional on a sense of subjective control, feeling responsible for one's own and others' safety, and trusting the community and its leaders to take appropriate action throughout the entire disaster cycle. Behaviour during earthquakes is, contrary to popular myths, not dominated by panic and irrationality. Besides the overarching goal of survival, people strive to maintain altruistic and rational social relations, even among groups of strangers. Explanations for these behaviours centre on the universal need to belong to groups, which allows people to engage in collective problem-solving while maintaining a sense of safety and normality. We note that many studies employ questionable methods. Theoretically, most of them rely on the intention-causes-behaviour model, which only accounts for under a third of the variance in behaviour (Sheeran, 2002). Decisions on how to prepare for emergencies are also shaped by cultural values, social representations of risk and emotionally-driven judgments. An integration of these would facilitate a more valid psychological framework for interdisciplinary earthquake research.

KEYWORDS: Human behaviour, seismic adjustment, literature review

1. INTRODUCTION

This paper examines the literature concerning what individuals and small groups such as households do in response to an anticipated seismic hazard, and what motivates this behaviour. Furthermore, it explores research on how people behave during ground-shaking and what influences decision-making and action in relation to such behaviour. Most of the studies reviewed focus on psychological causes of earthquake-relevant behaviour.

The paper starts with a review of how people prepare for earthquake occurrences. It then considers how psychological, social and environmental factors shape seismic risk perceptions. Following this, it shows that feelings of social responsibility and trust are powerful motivating forces for intentions to undertake seismic adjustments. Further, the literature spells out the importance of a subjective sense of control for implementing intentions to mitigate seismic risks. The next section of the paper deals with people's behaviour during an earthquake. The traditional panic model of disaster behaviour is contrasted with modern research findings and theories. These show the severe limitations of the panic model, and highlight new social scientific explanations for behavior in people caught up in earthquakes and other disasters. The final section summarises and critiques the findings reviewed. It argues that the literature often fails to heed lessons from modern social psychology. Furthermore, methodological shortcomings are noted. It concludes with recommendations for improvement of research in the field, while noting the progress made so far.

2. HOW PEOPLE BEHAVE IN ANTICIPATION OF EARTHQUAKES

2.1. How do people protect themselves from earthquakes?

This paper refers to the behaviours undertaken in anticipation of being affected by an earthquake as *seismic adjustment* behaviours. For the purpose of this paper seismic adjustments are all types of actions and behaviours undertaken by individuals and households that have the capacity to either reduce immediate risks of damage and loss during an earthquake, or to prepare for post-impact conditions that might adversely affect survival rates. The West Coast of the USA has been surveyed repeatedly to ascertain levels of seismic adjustment. Findings indicate that adoption and implementation has gone up over time, but not consistently so. The overall trend is that adjustments related to post-impact survival (such as storage of essential foods and amenities) continue to be by far the most widespread. In addition, earthquake insurance has increased from approximately 5% in 1973 to approximately 50% in 1993 among at-risk Californian homeowners (Palm 1995). However, pre-disaster earthquake-specific preparedness and mitigation adoption rates have not increased significantly from the early 1970s to the present time (Turner, Nigg & Heller-Paz 1986; Russell, Goltz & Bourque 1995; Nguyen et al. 2006).

Studies in other parts of the world have been more sparse, and little is known about longitudinal changes in adjustment rates. However, they tend toward the same conclusion as US-based research: A large proportion of respondents do nothing or very little to adjust to seismic hazards, and when they do take action, it is significantly more likely to be response and recovery-related than mitigative (Kirschenbaum 2005). The question that arises is: What human factors enhance or decrease seismic adjustment adoption rates?

2.2 Do people feel at risk?

Results from the Pacific north-west coast of North America reveal that people do not spontaneously think of earthquakes as a significant risk to their community (Jackson, 1981; Turner, Nigg & Heller Paz, 1986). However, residents do acknowledge that earthquakes have occurred and are likely to happen again. More recently, Armas (2006) found that almost all people surveyed in Bucharest had experienced at least one earthquake, yet 54% reported indifference to future seismic risks. This is one of the paradoxes within the literature – despite clear awareness and memories of past earthquake activity in respondents' communities, the day-to-day salience of earthquakes as risky events often seems to be very low, at least in the absence of

imminent risk. In short, a significant proportion of people in seismically active areas are either unaware or deny their risk. One exception was reported by Armas (2008), where, in a sample of severely vulnerable residents of Bucharest, 38% had daily thoughts about past earthquake experiences, and 67% lived with a daily fear of future occurrences. Factors predicting or correlating with perceptions of seismic risk encompass the psychological, social and environmental levels of explanation.

2.1.1 Psychological factors and perceptions of seismic risk

A number of psychological variables have been consistently linked to increased risk perception. First and foremost, past experience of damaging earthquakes has been found to increase risk concerns (Dooley et al. 1992; Lindell & Prater 2000; Rüstemli & Karanci 1999; Gruev-Vintila & Rouquette 2007). Earthquakes are events that create opportunities for narrating important stories about oneself and one's community. Their later rehearsal and retelling on social occasions can be considered one cause of their later effect on risk perceptions, as rehearsal of the emotionally charged events strengthens its memorability and makes the earthquake a salient part of the person's life history (Neisser 1996). The effect of the memorability of earthquake stories is further strengthened by studies that find a positive correlation between the extent to which one thinks talks and reads about earthquake hazards and seismic risk perception (Turner et al. 1986; Farley 1998; Lindell & Prater 2000; Gruev-Vintila & Rouquette 2007).

Optimistic bias (OB) is a pattern of judgments where people see themselves as being less likely to be harmed by future risks than peers of similar age and gender who they are asked to compare themselves to and more likely to be happy and healthy (Spittal et al. 2005). A number of studies have found that people display a general optimism in their relations to natural hazards (Jackson 1981; Burger & Palmer 1992; Helweg-Larsen 1999; Spittal et al. 2005). The consequences of OB for seismic adjustments can be negative. If people deny or ignore seismic risk, motivation for preparedness drops significantly. A number of other subconscious cognitive processes have been described as affecting seismic risk perception (Jackson 1981; Mileti & O'Brien 1992; Celsi, Wolfinbarger & Wald 2005). Typically they skew risk perceptions towards lower estimates than those obtained through technical analyses, thus providing people with a false sense of security, and, possibly, lower adjustment motivation.

2.1.2 Social factors and perceptions of seismic risk

Cutter, Boruff & Shirley's (2003) overview of the social vulnerability literature finds that groups with less social, economical and psychological control, such as females, the old and the young, ethnic minorities, the poor and populations with special needs such as physically or mentally challenged people, are most vulnerable to environmental hazards. Do increases in social vulnerability lead to stronger risk perceptions? A number of studies have found that females and members of ethnic minority groups report the highest risk estimates (e.g. Turner et al. 1986; Dooley et al. 1992; Mulilis 1999; Lindell & Prater 2000; Lai & Tao 2003; Paradise 2005; Armas 2008; Spittal et al. 2008). The links between socioeconomic status (SES) and risk perceptions seem to be somewhat irregular. On the one hand a number of studies have linked increasing educational attainments of residents in moderately developed countries to higher risk perceptions (Rüstemli & Karanci 1999; Paradise 2005). On the other, higher values on SES indicators such as income, education and home ownership have been linked to decreases in risk estimates in US respondents (Farley 1998; Lindell & Prater 2000). Contrary to expectations, older people are less likely to see earthquakes as a significant risk. (Turner et al. 1986; Dooley et al. 1992; Farley 1998; Rüstemli & Karanci 1999; Lai & Tao 2003; Heller et al. 2005; Spittal et al. 2008).

2.1.3 Environmental factors and perceptions of seismic risk

Some data indicate that objective risk corresponds to heightened risk estimates in at-risk people (e.g. Rüstemli & Karanci 1999; Lindell & Prater 2000; Armas 2008). Yet difficulties in separating out the influences of past experience, exposure to societal risk messages and proximity to seismic risk zones make it impossible to determine, on the basis of available results, whether technical risk estimates are linked to subjective risk

estimates in a consistent and predictable manner.

2.1.4 Does understanding and accepting the risk from earthquakes lead to risk reduction behaviour?

A number of studies have reported positive correlations between risk perceptions and seismic adjustment (e.g. Jackson 1981; Turner et al. 1986; Lindell & Prater 2000), in essence claiming that stronger risk perception motivates seismic adjustment more than weaker risk perception. However, these associations have often been of a small magnitude (e.g. Rüstemli & Karanci 1999). In addition, they usually relate only to certain types of adjustments – generally response and recovery-related items with utility mainly for the post-impact phase (Kirschenbaum 2005). Furthermore, it is often the intention to undertake adjustments that is found to be linked to perception, and intention is only moderately associated with actual adjustment (e.g. Paton et al. 2005). Not surprisingly, then, while Lindell and Perry's (2000) overview of household adjustment to seismic risk indicated that higher risk perception tends to lead to subsequent adjustment, their later work has partially disconfirmed this proposition (e.g. Lindell & Prater 2000; Whitney, Lindell & Nguyen 2004). This is corroborated by Armas and colleagues (Armas 2006; Armas 2008). They have shown that even in the face of extremely high levels of risk and vulnerability, several factors moderate the force that risk perceptions have on seismic adjustment intentions. These factors include social norms regarding trust and responsibility, beliefs about control and coping efficacy (which includes access to mitigative skills and resources), as well as the overarching socio-cultural norms that shape the expression of these thoughts, feelings and actions in a particular time and place.

2.2 How does societal trust and responsibility affect seismic adjustment?

People's perceptions of earthquake risk and adjustment behaviours involve processes that are profoundly social. People's risk perceptions and adjustments are influenced by whether and how they see and hear **others** attending to and responding to hazard. Corroborating this, Mileti and Fitzpatrick (1992) reported that seismic adjustments in their sample increased when respondents observed other people adjusting. Hazards and health threats are commonplace conversation topics, and communication processes in the family and among neighbours, friends and colleagues have an impact on risk adjustment. Farley (1998) showed that believing that one's neighbours were prepared predicted more adjustment, whereas belief that neighbours did not know how to prepare led to less adjustment. Heller et al. (2005) found that in families where helping behaviour was common-place, higher levels of hazard-related discussion predicted adoption of seismic mitigation adjustments. People develop a sense of social responsibility via peer influences and norms of social obligations (see Solberg, Joffe and Rossetto 2008). People learn about earthquake risks and how to adjust to them as much via informal networks as via official risk communications. These informal networks enforce norms of reciprocity and obligation, which can result in a sense of social responsibility that might motivate seismic adjustment intentions Paton (2008, see also Green 2008) argues that trust is a crucial factor that underpins adjustment adoption. According to Paton's model, trust becomes significant for seismic adjustment when there is little information about the hazard and the hazard is relatively unfamiliar. In his model, if people expect to be able to control a risk, this leads them to participate in their community in order to articulate problems and gain empowerment relative to civic authorities, all of which facilitate collective problem solving. The model predicts that if these goals are achieved, levels of trust in risk managers will mediate the impact these factors have on the intention to adopt adjustments. High trust will motivate people to adopt adjustments. Low trust will dampen this motivation.

2.3 How does a sense of control impact seismic adjustment?

In the preceding paragraph we showed how risk knowledge circulating through social networks can lead to a sense of responsibility for adjusting to seismic risk. However, this is contingent on having the right knowledge, and a sense that one can reduce seismic risk. For scientists the question, "What is an earthquake?" is one which evokes no fundamental ambiguity. However, lay interpretations of the earth's activity have been

found to differ in significant ways from scientific knowledge, not only in terms of the hazard it poses, but also in what causes it. Some give meaning to earthquakes via religious and other non-scientific frames of thought (Paradise 2005). The explanatory frameworks and types of knowledge held by lay people have profound consequences for their sense of control. Explanations which stress the uncontrollable causes of earthquakes, be they physical or supernatural, lead people to lose faith in their ability to control the environment, and can often induce an attitude of fatalism. Fatalism can be induced by, for example, mass media reports that do not stress accurate, rate-based information about why certain types of buildings collapse and others survive tremors. McClure and colleagues have shown that, for New Zealanders, having scientifically valid knowledge increases a sense of control. Feelings of control increase both motivations to undertake seismic adjustments and actual adjustment rates (e.g. McClure, Allen & Walkey 2001).

2.4 Drivers of seismic adjustment: Risk perception, knowledge, responsibility, trust and control

In sum, risk perception is not driven by scientific estimates of physical hazard. Instead, psychological and social factors shape risk perceptions, on both the conscious and sub-conscious levels. Sensing risk is in itself not enough to motivate seismic adjustment behaviours. Risk must be socialised and made visible through both formal and informal communicative networks. Peer influence and norms motivate feelings of social responsibility. Yet responsibilities will not easily be acted on unless people have both a sense of trust and a sense of control. Trust is important for community coordination of seismic adjustments. Control enables people to implement their adjustment intentions and avoid fatalistic attitudes towards disaster risk reduction. The sum of these factors - risk perception, sociocultural knowledge processes, responsibility, trust and control - induces seismic adjustment.

3. HOW PEOPLE BEHAVE DURING AN EARTHQUAKE

Unlike research on anticipatory behaviour, the opportunities for studying human behaviour in an earthquake are limited by physical as well as ethical constraints. Scientists are limited to simulations and experiments with somewhat dubious realism, or to post-hoc archival and observational data, which may not adequately represent the breadth of earthquake-related behaviour (Drury & Cocking 2007). Four major theories of social behaviour in emergencies and disasters have been suggested. They are reviewed together with further empirical work drawing on accounts of survivors, among other methods, to cast light on behaviour during earthquakes.

3.1 Panic theories

The oldest and best known theorisation is panic theory. Most famously associated with Gustave Le Bon's influential work, panic theories posit that reactions to collective threats and entrapment are characterised by negative emotions such as fear, hysteria and anger, a breakdown of rational thinking and social order, and non-adaptive behaviours such as flight and violent conduct, all of which are caused and exacerbated by the depersonalising influence of the crowd (Mawson 2005). Panic theories continue to exert a powerful influence on popular representations of disaster/emergency behaviour, on policy planning and decision-making, as well as on the sciences (Quarantelli 2002). Empirical studies of emergency behaviour, however, have found decisive evidence that largely falsifies the predictions made by panic theorists.. Ripley (2008) posits that a first response to disasters such as earthquakes is denial by those experiencing it, which can manifest in a delayed reaction. Delay relates not just to denial and OB concerning the event's disastrous consequences, but to a desire to stay with the familiar and, for people who have survived similar disasters in the past, to a sense that they will survive the current one too. It may also reflect overconfidence in the ability of one's home to withstand the event.

3.2 Emergent norm theory (ENT)

The first theory that challenged the received wisdom of panic theories is the emergent norm theory (ENT) of collective behaviour. ENT posits that a crisis such as an earthquake overrides pre-existing norms and hierarchies (e.g. status, established social relationships and division of labour) forcing people to create new normative structures to guide their behaviour. ENT makes a number of predictions regarding how groups and individuals are likely to act in a crisis (Aguirre 2005, see Solberg, Joffe and Rossetto 2008 for further details). It's most important contribution to the study of emergency behaviour is its insistence on the social construction of disaster responses. In short, this means that disaster responses are primarily group decisions shaped by social dynamics, rather than primitive emotional and behavioural reactions to environmental stressors. Disaster responses reflect group deliberations that are rational given the contextual constraints (time, space, skills, knowledge, cohesion and leadership) the group functions in. These responses maximise survival chances and preserve the social world.

3.3 The social attachment model (SAM)

As can be seen, ENT is largely concerned with the behaviour of the group, rather than individual-level processes. While ENT is useful regarding certain situations, a person might, for example, be alone in a house when an earthquake strikes. The social attachment model (SAM) of human behaviour in disasters (e.g. Mawson, 2005) focuses on the maintenance of proximity to familiar persons, objects and places as the primary motive for action in emergencies. In this model, flight is seen as a general response whereby people flee as much *towards* familiar attachment objects as *away from* dangerous situations. Mawson (2005) proposes a 2x2 predictive typology of responses to disaster, combining the factors of perceived degree of physical danger (mild/severe) and levels of social support available in the situation (present/absent). In general, higher social support dampens flight tendencies, while higher danger enhances them. Only in cases where social support is very low and danger is very high would one expect to see classical panic behaviours. In cases with high social support, high levels of danger will typically provoke and orderly and relatively calm evacuation towards safety.

3.4 The social identity theory of disaster response (SIT)

Like ENT, the SAM posits group belonging and social roots to be at the heart of earthquake-related behaviours. The newest model used to predict disaster behaviour, social identity theory (SIT), corroborates this motivation. SIT, as applied to disaster behaviour (Drury & Cocking 2007), operates from the premise that shared social identity determines social behaviour. Social identity is that part of all people's identity that is formed when people categorise themselves as belonging to a particular group. This can range from more fixed groups such as gender and socio-economic status, to more situationally-evoked groups such as those who find themselves trapped with others within particular situations. SIT is applied to disaster behaviour primarily in order to explain persistent observations that cannot be explained satisfactorily by ENT or SAM; Primarily, altruistic behaviour among strangers and the striking absence of panic in most disasters, even when crowds of relative strangers are gathered. SIT distinguishes between a psychological crowd, which is united by networks of shared identities and motivations, and mere aggregates of people without shared identities. SIT predicts that psychological crowds, such as people facing a common threat from ground-shaking, will display greater concern towards others (both familiars and strangers) in the crowd; that there will be greater coordination, help and altruistic behaviour towards all crowd members; and that there will be greater expectations of support from the crowd. Thus the disaster itself creates a shared bond between those experiencing it. A greater degree of shared identity has been found to lead to such behaviours and cognitions on the basis of a wide array of research methods: experiments, computer simulations, interviews with disaster survivors and archive data.

3.5 What this means for earthquake engineering and building design

The theories mentioned each emphasize the social aspects of the situation in which people facing a disaster find themselves. Their predictions are particularly important in terms of understanding that people do not act as

sequestered individuals in disasters but move with or towards other people. In the rare instances where engineers design structures with any model in mind concerning how people might evacuate them in an emergency, they assume that people move out of buildings like water (see Ripley, 2008). This analogy overlooks that water molecules do not have social ties (e.g. a person may look for their child before thinking about evacuating), they also overlook the fear response with the resultant delay and denial that it can produce, and that people, unlike molecules, make decisions in accordance with their risk perceptions. Thus insights into the social and individual factors that influence human behaviour during earthquakes should have a radical impact on the engineering of buildings.

4. CONCLUSION

In sum, the literature reviewed suggests that perceptions of risk, social responsibility, trust and a sense of control facilitates seismic adjustment behaviours. Behaviour during earthquakes is motivated by the need to maintain social groups and psychological functioning as much as the desire to survive. At a less individualistic, more societal level, cultural elements can promote (or indeed hamper) survival-inducing behaviours.

Many of the studies cited in this paper suffer methodological problems: Measures of risk perception, attitudes and adjustments are not standardised, which makes it hard to compare studies. One cannot easily make causal inferences from the many survey-based studies. They provide evidence only of correlations. Also, many of the studies are cross-sectional, making it difficult to accurately measure change over time, again with ramifications for the possibilities of making informed judgments as to causal processes. However, this range of studies can lead to well-grounded, testable hypotheses of causal chains. A further, striking methodological bias is that in a majority of the studies the sample is constituted solely by homeowners. Although the reasons for this are obvious - they are most likely to have the opportunity to make strong adjustments - non-homeowners' adjustment behaviours and risk perceptions are largely opaque. Future work must redress this imbalance. Theoretically most authors rely on the tenet that intention causes behaviour. Meta-analyses show that such theories explain about 30% of behaviours (Sheeran 2002). We recommend that researchers widen their scope to include nonconscious psychological processes (such as the influence of environmental cues), as well as incorporating cultural and social representations of risk and risk management (Joffe 2003) into their explanatory frames.

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