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ATTITUDES TO DISASTER IN JAPAN

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Abstract: During disasters, every second can be decisive. In Japan, after the Great East Japan Earthquake (GEJE) and tsunami in 2011, survival was largely determined by timely evacuation. Evacuation procedures are highly developed in Japan and people are drilled in evacuation from childhood. Evacuation behaviour is complex. Seemingly illogical behaviour often obeys a hidden rational. This paper reviews the state of current knowledge and summarises the factors that researchers have found correlate with the decision to evacuate. The paper then reports recent research at Kyoto University to document evacuation after the 2011 event and to understand evacuation behaviour and their level of preparedness. One of the aspects studied is the difference between what people say they will do in a disaster and what they actually do in a real event. For example, in Japan many respondents said that they would run to a safe place, but in fact many people went home, often into danger, to seek and care for family members. (Murakami and Umezu. 2011) This paper examines people's attitudes to risk and how people imagine they will behave in the abstract while no danger threatens them and they have to imagine themselves in a crisis situation

Current understanding of evacuation behaviour

Warning plays a significant role in who evacuates and who does not but risk perception is also a vital piece of the puzzle. However, evacuation decision making is a complex processes that is difficult to categorize. (Dash and Gladwin, 2007) Although emergency managers assume people will act rationally – hear a warning and leave when told to do – more often than not, many of those at greatest risk choose not to evacuate in time. In urban areas people often decide to evacuate too late, becoming caught in traffic jams. Or they may hear about the traffic and not evacuate when they should.

The failure to prepare for emergencies is often viewed by emergency managers as irresponsible. Hutton (2012) suggests that this is neither accurate nor helpful and that the focus of emergency managers should be on how best to engage and motivate individuals and communities in activities which will enhance their capacity to adjust to disastrous events. There is a considerable body of knowledge on the disaster experiences of the general public, although most of the research is on natural disasters in developed, Western countries. (WikiPDRR community authors, 2007) In summary:

- People usually do not act on the first warning, but often first deny the possibility of danger and seek confirmation or clarification.
- People strive to be together with their family or other “in-group”.
- People evaluate disaster related information based on both its content, and the credibility of its source.
- People's motives and behaviour are mostly altruistic and rarely selfish.
- Inaction, helplessness and panic are rare.

There is a considerable literature on evacuation from hurricanes and weather related flooding events and, although the warning times are generally considerably longer than for earthquakes and tsunami, some of the findings are relevant to evacuation behaviour in tsunami. A comprehensive review by Baker (1991) of hurricane evacuation research concluded demographic characteristics (sex, age, education, income, ethnicity, marital status, and the presence of children in the home), and previous experience (previous hazard impacts and previous false alarms) have inconsistent correlations with hurricane evacuation.

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In contrast, he concluded hurricane evacuation is most strongly related to people's prior perceptions of risk, storm-specific threat factors, the hazardousness of households' locations, the characteristics of the structures in which they live, and actions by local authorities. For example, people living in mobile homes were twice as likely to evacuate in a timely manner than households in solid dwellings.

Drabek (1969) interviewed 278 families who were suddenly evacuated from their homes on 6 June 1965 when a sudden flash flood hit Denver, USA. Approximately 30% of the families reported that they tried to return home after initially leaving. The reasons given were: to more adequately secure their homes; to get specific articles; to turn off gas or electricity; and that additional information indicated they had more time to evacuate than first indicated. Over a quarter of the respondents said that they "went up on the hill." But it was not fear that their houses might be damaged that motivated their evacuation but curiosity. They simply joined hundreds of others who were watching the river but whose houses were not threatened.

Data about the evacuation from Hurricane Lili that hit Louisiana USA as a Category 1 hurricane in 2002 are consistent with this review by Baker (1991) of hurricane evacuation studies, which concluded evacuation is not strongly correlated with the source of information about storm conditions or the frequency of media monitoring or maintaining a tracking chart. (Lindell et al, 2005). The results of this study support previous findings by Prater et al. (2000) that local news media, especially television, are the most extensively used source of hurricane information for risk area residents. However, this study extends those findings by revealing evacuation decisions were more strongly correlated with reliance on peers and local authorities than with local news media.

Research also supports various hypotheses about hurricane evacuations.

- Hurricane evacuation decisions are predicted by coastal proximity, building structure type, information sources, and absence of evacuation impediments.
- The timing of evacuation is predicted by time of day i.e., the evacuation rate is higher in the morning
- Evacuation preparation time can be determined by the time needed to leave work, travel to home, gather everyone who would evacuate, pack items needed while gone, protect property from storm damage, shut off utilities, secure the home, and reach the main evacuation route. The preparation time distribution will be similar to that estimated by Lindell et al. (2005), which ranged from approximately 60 to 450 min, with a mean of 229.9 and a standard deviation of 85.2.

Research suggests that evacuation is twice as high in households with children as without. This was independent of the age of the head of the household or the presence of seniors. (Heath et al, 2001a) This behaviour has been attributed to children being frightened and wanting to leave immediately (Drabek, 1968) or to adults anticipating more harm to children than to themselves (Fischer et al, 1995). Households that act responsibly toward pets in general also act responsibly in disasters but pet attachment is not statistically associated with evacuation and, is therefore not a useful predictor of household evacuation behaviour. In contrast, low pet attachment was positively associated with pet evacuation failure. (Heath et al, 2001b). Households that act responsibly toward pets in general also act responsibly in disasters but pet attachment is not statistically associated with human evacuation failure and, is therefore not a useful predictor of household evacuation behaviour. In contrast, low pet attachment was positively associated with pet evacuation failure. (Heath et al, 2001)

A team at Kyoto University (Liu et al, 2007) compared the response of household to warnings of earthquake and flood disasters. The reasons for non-evacuation were quite different. In the case of the Hanshin-Awaji (Kobe 1995) earthquake over half of residents (54%) failed to evacuate because of fear of after shocks or because they were unable to because of building damage or fire (38%). In contrast, nearly half of residents that failed to evacuate in response to the Niigata flood (2011) warning thought they still had time (24%) or thought their house was safe (23%).

Perry (1979) provides a useful model of evacuation that posits the following determinants of successful evacuation behaviour. People are more likely to evacuate:

- 1 The more precise the individual's adaptive plan.

- 2 The greater the individual's perception of real threat.
- 3 The higher the level of perceived personal risk.
- 4 The extent that household members are together or accounted for.
- 5 The closer one's relationship to extended kinsmen.
- 6 The greater one's participation in the community.
- 7 If there are no aged members in the family.

During disasters, every second can be decisive but most people are unable to think clearly, and their decision-making is at best sub-optimal. There is evidence from previous disasters, notably the 2004 Indian Ocean tsunami, that foreign visitors have much greater difficulty than national in responding appropriately and evacuating in time. There is also evidence that more women die than men, for example in the 1991 Bangladesh cyclone, the 1995 Great Hanshin-Awaji Earthquake, the 2005 Kashmir Pakistan earthquake and the 2009 L'Aquila earthquake. Although building quality is the most significant factor in the number of fatalities in sudden impact disasters such as earthquakes, this fact alone does not account for the large gender differences in casualty rates. (Mehta, 2007 and Alexander, 2013).

Gantt (2012) in a review of disaster psychology literature entitled 'Dispelling the myths of panic' conclude that human responses during disasters are rarely consistent with those expected by the government and the media. Unfortunately, these perceptions have crept into disaster management folklore. A careful review of social science and disaster research suggest that rather than responding in irrational and/or self-interested ways, people typically respond in rational and pro-social ways. Perry and Greene (1982), suggest that three factors directly affect an individual's ability to properly assess the risks from a disaster or emergency. These include credibility of the authority; the warning message itself, including any risk relevant information; and past experience with similar scenarios.

One way of attempting to understand what at first sight appears to be irrational behaviour by people not evacuating immediately is in terms of risk taking. Cameron and Shah (2013) investigated the relationship between natural disasters and individuals' risk-taking Behaviour using data from experiments conducted in Indonesia in 2008. They found that individuals living in villages that have experienced a natural disaster behave in a more risk averse manner than individuals in otherwise like villages. Their data suggest that expectations change as a result of having experienced a natural disaster. People who have recently experienced a disaster attach a higher probability to experiencing another in the next twelve months and expect the impact to be more severe than people who have not experienced one. This may go some way to explaining why survivors are so risk averse now and place such a premium on safety. But their work does not address the more interesting question of why so many people took a risk in not evacuating immediately in the Tohoku tsunami.

Evacuation preparedness in Japan and the 2011 tsunami

Evacuation procedures are highly developed in Japan; more than in most countries vulnerable to natural disasters. People in Japan are drilled in evacuation from childhood and there are extensive government funded awareness raising campaigns and adult training sessions. There is evidence that the vast majority of nationals evacuated successfully in 2011 earthquake but that many evacuation centres were overwhelmed by the unprecedented size of the waves. The casualty rates amongst foreigners were as high as predicted by other similar events, but exceptionally, more men died than women, Koyama et al (2012).

Various sets of factors affect the level of preparedness and appreciation of disaster risk. Firstly, people's attitude to disasters, their age and gender, marital status, children, education, and secondly people's preparedness and disaster knowledge, and thirdly, environmental factors such as building reliance, urban design etc. While the first set of factors is individual and independent of other people or organizations, the other sets are related to what people have learnt through their life and what their society and community have prepared and given them.

In Japan, after Tohoku earthquake in 2011, the majority of deaths were caused by a tsunami that was much larger than had been anticipated and prepared for. There is evidence that the vast majority of nationals evacuated successfully but that many evacuation centres were overwhelmed by the unprecedented size of the waves. The casualty rates amongst foreigners were as high as predicted by other similar events, but exceptionally, more men died than women. (Koyama et al, 2012). Timely unambiguous early warning and making the right decision to evacuate immediately are obviously crucial to survival. But what makes people evacuate immediately? And are government programmes of awareness raising and drilling working effectively in Japan? This research produced some surprising results, for example experience of drills had no effect. It was almost as if some people were complacent and thought they had more time. This is perhaps not so surprising.

The Great East Japan Earthquake was the most powerful earthquake known in the history of Japan, also one of the most powerful earthquakes in the world. producing 5% of the global cumulative seismic energy released since 1900 (Witze, 2011). The epicentre was located in the east of Tōhoku with a depth of 32 km and the earthquake has affected almost 650 km of the Miyagi, Sanriku, Joban and Kanto coastline along the Pacific Ocean shores of Northern Honshu Island (Witze, 2011). A number of large foreshocks and hundreds of aftershocks are reported for the main earthquake. The main earthquake was followed by a major tsunami with an estimated wave height of 38.9 meters (Yomiuri Shimbun 2011), and travelled up to 10 km inland in the Sendai area.

Japanese early warning system and evacuation preparedness

There has been no lack of effort to research the causes of the high fatality in the 2011 Tohoku tsunami. Mori and Takahashi (2012) report a survey by 300 researchers in more than 5,200 locations. But this research on the action of the tsunami wave rather than the behaviour of people in response. Commenting on tsunami preparedness researchers at Tohoku University suggest that despite an increased awareness of tsunami risk, including increased knowledge, disaster preparedness and willingness of local populations to evacuate, the response to tsunami warnings still appears to be inadequate, pointing to lack of awareness by at least some individuals, an over-reliance in defence mechanisms or a failure to transmit knowledge from previous events. (Esteban et al., 2004).

The possibility of warning is conditioned by the extent to which the different types of disaster can be predicted reliably (Fritz and Williams, 1957). Japanese earthquake engineers are amongst the best in the world and scientific considerable effort has been directed to earthquake prediction (Davis, 2012). A prediction for the GEJE 2011 was initially announced in 2001 nearly ten years in advance identifying the possibility of a magnitude M8.0 or greater earthquake occurring in an area covering northern Honshu and Hokkaido. What the scientists failed to anticipate was both the size of the 2011 event (M9.0) and the detailed response of the affected population. Both these factors contributed to the high death toll. This paper examines some important aspects of behaviour to affect survival rates.

The accepted wisdom, at least prior to 2011, was that Japan was as prepared for earthquakes as any nation and that its people, through extensive training, drill and education programmes were ready to respond appropriately to protect their lives. A well-developed public earthquake early warning (EEW) system has been operating in Japan since October 2007. People near the epicentre received the EEW about 15 to 20 seconds before the most severe shaking occurred. Even such a brief warning contributes significantly to saving lives (Murakoshi et al. 2008).

Some 90% were able to take advance actions to save their own lives and those of family members. Fujinawa and Noda (2013) argue that this high rate of effectiveness is the result of education both in schools and in society at large. People in Japan had been imagining an earthquake and training themselves regarding what actions should be taken when an EEW is issued, and this advice is given at schools, by the local government and mass media. Comprehensive earthquake safety manuals were written by Prof. K. Meguro of Tokyo University (Meguro 2012) to make people familiar with earthquake risks and to prepare to take the most suitable action depending on 'time, position, and occasion'. The development

of systems for schools was led in particular by Professor M. Motosaka of Tohoku University (Motosaka and Homma, 2009).

But this view of readiness has been challenged, not least by the huge death toll caused by the tsunami. Comfort (2011) suggests one reason for the apparent lack of preparedness for the tsunami was that the Disaster Countermeasures Basic Act of 1961 that assumes a common level of response to all types of hazards. Although Japan has experienced tsunamis, they were not identified as a disaster category that merits attention on its own. Instead, countermeasures for tsunamis were treated as a need generated by earthquakes. To what extent this played a role is uncertain. What is clear is that the size of the tsunami was much greater than people anticipated and many people were unable to evacuate in time. Yun and Hamada in a forthcoming paper highlighted the difference between 66% of the survivors who evacuated within 20 minutes and only 11% of the survivors who did not or could not evacuate. The reasons people gave for not evacuating in time were: a belief that their current location was safe enough; waiting for additional information. Additionally, 30% of people who evacuated within 20 minutes and became victims had difficulty reaching an evacuation centre, or going to an unsafe refuge. 20% of people who didn't evacuate in time but who survived went back to their houses or other places before the tsunami ended to find family members, and returning to their homes to find their belongings. This finding supports previous research by Suppasri et al. (2012); Quarantelli (1985) and Riad (1999). The authors conclude that that early evacuation and safe location are key factors that lead to survival.

The Japanese Government and scientific community have learnt the lessons from the 2011 tsunami, not least in terms of communication. Before a disaster the media, including the press, radio and television as well as social media, can be most influential in increasing people's preparedness and awareness of the risk. And after a disaster, the media has an important role in informing people about the level of risk and evacuation to the safe areas (Amini Hosseini et al., 2011). In particular the exact form of the early warning has been simplified to ensure that people evacuate immediately without stopping to calculate, based on the predicted magnitude, whether they have time to delay or do something else, such as rescue friends, family or belongings.

Evacuation behaviour

Considering the gap between the main earthquake and arrival of tsunami waves, and the fact that it happened during daytime, it was expected that people in the affected areas would have had time to evacuate. But in the first 10 minutes nobody tried to evacuate, then only a few people, who were living in the areas nearest to coast left their homes to escape from danger. Most residents started to run to a safe zone about half an hour after the main shock (Murakami et. al. 2012). In areas distant from the coast, people did not take the warning of 2011 tsunami seriously. They remembered their previous experience of a tsunami and assumed that it would have a similar low inundation height. Accordingly, many people delayed the evacuation and did not attempt to escape in time. However, the 2011 tsunami was much more severe than any previous tsunami in living memory and produced a much higher inundation compared to 2010 Chilean tsunami. It seems that people's experience of recent events clouds their judgment and affects their reaction. It also seems that being closer to the danger zone is a crucial factor in people's preparedness.

In addition there are other factors that play a vital role in critical moments. Multiple announcements on the radio about tsunami height, particularly is the Natori city which was first declared 6 meters and then over 10 meters Murakami and Umezu (2011), spread doubt made people discredit the warning and cause critical loss of time. The second announcement, which indicated a higher inundation height, provoked people to relocate to a place of higher altitude. Some of them were hit by the tsunami and washed away because they lost time by obeying traffic rules and sticking in slow moving or congested traffic.

We interviewed thirteen survivors who were living in temporary housing. Four women and nine men, ten were over 45 and three were less than 45 years old. As Table 2 shows only one out of the thirteen people ran away in time. He was a 13 year-old boy. All other twelve just attempted to help others or tried to return home for any reason other than escape. Five

of the survivors were actually hit by tsunami and could only survive with great difficulty. One of them was in water for 24 hours. Of the five who went to help others, they all mentioned trying to convince elder people to leave their houses and helping them which made their evacuation speed much slower.

Table 1. Reaction after the tsunami warning

Use car to evacuate	Help people	Return Back home	Run to safe place	Trapped by tsunami
46%	38%	54%	4%	38%

Factors influencing fatality rates

1. Making right decision in time to run to safety rather than going back home
2. People's preparedness and being familiar with this kind of intensity of disaster.
3. Having accurate and realistic assessment of the risk rather than an over optimistic impression created by a smaller recent disaster such as the Chilean Tsunami.
4. Cultural inhibitors on people's behaviour, for example obeying traffic regulations, when the normal rules of behaviour might usefully be suspended in a crisis situation.
5. Multiple announcements on the radio about tsunami height that caused doubt, disbelief and loss of time.
6. Helping people and seeking family members.
7. Fatalities were higher amongst those furthest from an evacuation centre.
8. Time lost in convincing elderly people to evacuate and helping them move.

Attitudes to risk

The previous sections examined how people behaved after the main shock of 2011 Tohoku earthquake early warnings and the critical issues that influenced people's decision making. This section examines the people's attitudes to risk and how they imagine they will behave in the abstract while no danger threatens them and they have to imagine themselves in the crisis. It is based on a questionnaire amongst students at Kyoto University and other universities in Japan all of whom were aware of and sensitive to the 2011 disaster. The aim of this survey was to investigate in greater depth why people seem to have problems making the right decision to evacuate immediately to a safe area and what factors might influence people's behaviour. Greater understanding of the thinking processes of people when they imagine themselves in a similar crisis will help devise policies to reduce fatalities in future disasters. It would be possible by comparing the result of questionnaire with what we could find through our interviews and site surveys.

The questionnaire was distributed amongst graduate and undergraduate students including different nationality and gender on paper after various university lectures and disseminated on the Internet. There a total of 215 responses, 121 from the paper based version and 94 on the Internet. Of these 186 respondents answered the questionnaire.

The respondents came from 41 different countries. For the purpose of the analysis presented here they are divided into Japanese (19%) who are familiar with their country and had been drilled in tsunami awareness and evacuation procedures since childhood, and foreigners (81%) who in the main were not trained in tsunami evacuation but most of them have experienced the 2011 tsunami either directly or indirectly. The respondents' level of tsunami awareness was tested with a number of questions about awareness, preparedness, experience, and knowledge of his or her living area and understanding of the types of natural disaster that might threaten them. The main question was: "If earthquake occurs then what would be your reaction?" The pre-coded possible answers were: "Run to the safe area, return home, help other people or looking family member? This pre-coded range of possible behaviour was derived from findings from previous research described earlier about people's actual reactions in the 2011 tsunami.

and they have no chance of reaching home in the time. Car ownership, however, does not affect whether people go to help others. Clearly there will be people living nearby – friends, neighbours or strangers – who are in need of immediate help and people disposed to help others are not dependent on transport to provide assistance.

Table 5. Effect of transportation mode on people's behaviour

Look for family	Private vehicle	Public transportation	Help people	Private vehicle	Public transportation
	24%	6%		16%	24%
Other	76%	94%	Other	84%	76%
N = 92 Chi-Square P = 0.02			Chi-Square P = 0.96		

Table 6 shows the effect of having had experience of disaster drills and experience of disaster have previous disasters. Neither seems to have an effect on either helping people or running to a safe area.

Table 6. Effect of having been drilled and disaster experience on people reaction

Helping people	Having been drilled	No drill	Run to a safe place	Experience of disaster	No Experience
	22%	17%		38%	38%
Other	78%	83%	Other	62%	62%
N = 201 Chi-Square P = 0.45			N = 195 Chi-Square P = 0.8		

Two other factors that authors expected might have influence on people's reaction in crisis were having had experience as a volunteer and distance from home to work. Neither experience of volunteering nor distance seem to have an effect on the altruistic behaviour of helping others in crisis situations. (Table 7).

Table 7. Volunteer experience and effect of distance on helping people in emergency time

Help people	Volunteering experience	No volunteering experience	>20 minutes distance	≤20 minutes distance
	20%	19%	21%	20%
Other	80%	81%	79%	80%
N = 204 Chi-Square P = 0.87			N = 179 Chi-Square P = 0.90	

Methodology

Two methodological issues need to be highlighted. Firstly, it should be emphasised that this research is based on a sample of only 200 people in Japan who were imagining how they would respond rather than actual behaviour of survivors. Clearly people rarely act exactly how they imagine. And it would be difficult for people in other places to imagine what would happen in a tsunami. However, the majority had recent experience of the 2011 tsunami. They were living in Japan and had either direct experience of surviving the tsunami or had friends or relatives who had. Secondly the respondents were mainly students and therefore unrepresentative of the wider population in terms of age profile and educational level.

Conclusions

This paper reported research designed to isolate the factors that determine whether people, faced by the warning of an imminent tsunami, would help others rather than fleeing to a safe place. The findings can be divided into four categories.

Firstly, the factors having the biggest positive impact are close-to-reality evaluation of risk, a concise and specific warning given to people at the right time, and lastly people's capability for coming up with the right choice of action. Secondly are factors such as sex, marital status, whether people are native to the area, and the extent to which people have made proper preparations which might have a significant effect in saving lives.

Thirdly are factors that most surprisingly seem to have little impact in evacuation choices and survival rates, saving people's lives include, namely, prior training, awareness raising and drilling. Private vehicle ownership, has an effect on whether people decide to go in search of family members, but has little effect on whether they help others.

Fourthly, there are those factors that seem to have a negative effect, most notably previous experience of natural disasters. In contrast to other studies that found people were more risk averse after having experienced a previous disaster, this study found that those with experience of disaster were more likely to go to help others rather than evacuate to safety.

Despite the intense efforts in Japan to prepare the population for disaster, this study suggest that less than half the population is likely to respond correctly.

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