Handout 13.2: Homework Assignment 13.1

1. The following article is an extract of a paper written by Heather Allan and Margaret Davis, both of the Division of Risk at Glasgow Caledonian University in Scotland. Read the article and identify and summarize the important risk communication issues contained in the article, and list things you believe as an emergency manager you should know about or do to effectively educate an audience about how to protect against losses in a future earthquake, etc. Your summary should be two pages in length. This assignment is due in one week.

Earthquake Risk Prediction

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Earthquakes

Earthquakes are considered to be one of the most dangerous of all natural disasters, mainly due to the sudden-impact they bring with hardly any forewarnings (Alexander, 1998). They are 10 times more destructive than any other natural hazard and they should be prepared for (Eiby, 1980).

The earth's crust is divided into seven moving plates and the biggest and most frequent events occur in zones close to the seven plates' boundaries. In California, the San Andreas Fault is where the Pacific and North American Plates slide past each other. It is not a smooth and continuous process and these two plates are mostly locked together by friction. When pressure builds to a certain point, resistance becomes too great and the plates lurch along their predicted paths and an earthquake occurs (Reader's Digest, 1998). It is a powerful force of nature and there is nothing man can do to prevent earthquakes from occurring. The best man can do is observe and record the earth's movements and apply gained knowledge to early warnings.

The global number of natural disasters has been increasing over the course of the 20th Century although the aggregate number of natural hazard events such as earthquakes, flooding and tornadoes generally has not (Tobin & Montz, 1997). This could suggest that human influences are involved in determining the scale of a natural disaster. World population is now reaching 6 billion people which means it has tripled this century (Southwick, 1996). The global economy production has quintupled since 1950 (Brown, 1996) and there are 4 billion more people now variously exposed to environmental hazards than there were in 1900. The consequence of a natural event perhaps would not be so great if these 4 billion people were housed in well-planned communities and had economic stability, but this will probably never be the case.

Earthquake Prediction

It would be of great benefit to society if it could know when a disaster will strike and it is ironic that the most destructive natural hazard is also the least understood. The 19th century was the Golden age for all studies to do with the earth and in this time the invention of the seismograph by John Milne (1850-1913) took place that gave society the ability to analyze earthquakes. Scientists now feel close to unveiling a sound method of prediction and there is a belief that it will be a reality in the near future however, the pieces do not yet quite fit together.

A comprehensive earthquake prediction should specify the location of the event, the geographical area likely to be affected, the time interval during which the event is expected to occur, the expected magnitude range of the tremors, and other physical parameters. Any

prediction however will not be 100% accurate however and this is due to the “confidence level representing the percentage of likelihood that the earthquake will occur as predicted” (Alexander, 1998, p 58).

There have been earthquake predictions made in the past; the most famous being that in Haicheng in China on the 4th February 1975 (Adams, 1975). This was done by a combination of instrumental monitoring and observation of foreshocks. A mass evacuation program was launched and in those few hours many thousands of lives were saved before a devastating earthquake of 7.3 magnitude shook 22 million m2 of the city. The death toll stood at 1,328 and 16,980 injured (Haicheng Earthquake Study Delegation, 1977). This was an extremely low figure considering the location was in a densely populated area. The Haicheng prediction still remains the only large-scale accurate prediction made, even though the Chinese have claimed that at least ten earthquake predictions have been successfully predicted since 1975 with magnitudes of 6.5 and above (Blundell, 1977).

Today, there are promising signs that accurate predictions might be made in the future with the use of space technology. It seems that by looking down to the earth with specialized machinery, more data can be gathered as to the state of the tectonic plates and the pressure of each can be measured to indicate if an earthquake should be expected. However, no significant prediction, thus far, has been made from this method. The VAN method is where various stations in an area pick up SES – Seismic Electrical Signals discovered by physicists Varotos, Alexopoulos and Nomikos. During 1988-89, they made 17 accurate predictions in various locations each measuring a significant magnitude. It was the exactness of the location, time and magnitude of the predictions that excited scientists. There still remains uncertainty, however, and much depends on the accuracy of the stations receiving the signals. Only if these stations can give accurate readings can the rest of the process be 100% certain (Tazieff, 1989: p85).

It must be remembered that the main purpose of earthquake forecasting is to reduce loss of life and damage to property by allowing time for preparation (Alexander, 1998). A falsely made prediction could cause panic and unnecessary disruption to many lives. This was the case when in December 1990 when Iben Browning made a pseudoscientific prediction (unfounded upon scientific fact). This prediction was inaccurate and had serious detrimental implications in the New Madrid Seismic Zone in mid-America.

Risk Management in Earthquake Prediction

There are always risks facing society; it is how we mitigate these risks, which is the real skill. Even in Great Britain societal risks exist. The country has suffered many man-made disasters in the past affecting many lives. Events all too familiar to the public are the Piper Alpha Oil Platform fire (1988), the Exxon Valdez pollution (1989) and the rail accidents such as Clapham (1988) and Paddington (1999). However natural disasters are much less frequent. Britain would class flooding as a potentially more devastating hazard than earthquakes but the risk of earthquake does exist. There is a known fault down the middle of the Atlantic stretching towards Iceland (Department of the Environment, 1993). This risk is not high and the country should probably never feel the full force of an earthquake but because of this, the population, government and buildings are ill prepared for any disaster.

Natural disasters in essence cannot be prevented and Risk Management techniques for this sort of risk are that of the mitigation of the consequences rather than prevention of the event itself. There is obvious difficulty in quantifying the risk of an earthquake, however, with prediction society could know roughly what to expect and make provisions for the type of earthquake forecasted. Schools could be closed, buildings re-enforced and the public educated as to how to react to the actual tremor and the damage it will cause.

In an area such as California, everyone knows that the threat of earthquake exists and is high, because of past events. A weak prediction has been made in California by scientists stating that some time in the next few decades a massive earthquake will occur. It is not known when or where specifically, but the way it will happen and the effects are known. It is commonly termed 'The Big One', the official term for it is 'a standing prediction' (National Research Council, 1978). It has been predicted that the two main cities; Los Angeles (L.A.) or San Francisco could be hardest hit with the potential for either to fall into the sea. If this were to happen it would result in massive loss of life and property and affect the world, as California is a significant contributor to the world's economy.

To those living away from these areas it may be puzzling as to why these areas are so desirable if the risk is so great. It is here that we see the conflict between risk and benefits. Most residents in California have a high standard of living and enjoy a consistently good climate. Therefore residents choose to live with the risk of earthquakes. Many argue that because the risk cannot be seen or predicted accurately it is something of a myth and many do not even bother to consider the potential devastation of a quake. It is also seen as impractical to prepare adequately for a prediction, as measures such as knocking down hazardous buildings would be too costly. The best prediction a community could get is advanced warning of around 2 years together with an assurance of the location and magnitude (National Research Council, 1975). This would give adequate time for all residents to be made aware of the threat and to make reasonable preparations.

In 1994 an unknown fault released enough energy to cause an earthquake of magnitude 6.7. It occurred under the suburban town of Northridge in the San Fernando Valley, North L.A. It caused 57 deaths and was classed as one of the most expensive disasters in US history with losses of $25 billion and estimated losses reaching $44 billion (OES: 1997). In the HAZUS 99 report into the Average Annual Earthquake Losses for the United Sates complied by FEMA, it claimed that losses in the U.S. add up to around $4.4 billion per year with 84% of the losses occurring in California, Washington and Oregon. California State's losses alone amount to $3.3 billion of the total (Bolin & Stanford: 1998)

The mitigation of earthquake risk varies in each country. There is a large split between the efforts in developed countries and those in developing countries. The recent earthquakes in El Salvador and India (2001) that happened less than a month apart show this. Both these quakes were significant in magnitude and brought numerous casualties – the India earthquake measured 7.9 magnitude and hit in the heart of a city claiming the lives of an estimated 20,000. The Indian earthquake measured the same magnitude as the recent Seattle earthquake (2001). The most alarming fact to come of the comparison is that there was only one casualty as a result of the Seattle Earthquake. He died from a heart attack (BBC News, 2001). It is clear from the death

tolls that the West Coast of America has developed cities with earthquake hazard in mind. This could be due to California knowing there will be a devastating quake someday, or that their economy and land management is better planned. It must be remembered that the highest priority in responding to earthquake prediction is to save lives, with secondary attention to minimizing the social and economic disruption and property loss. (National Academy of Sciences, 1979).

This paper acknowledges the many ways **Risk Management can be used to mitigate earthquake risk. Many studies of earthquake risk focus upon the physical techniques that can be used to reduce the risk of harm caused by an earthquake. This can be evidenced by the continual upgrading and renewing of engineering methods to make structures more secure in areas subject to earthquakes. This article puts forward the following conclusions.**

A Nation's Wealth

What appears to have developed are different preparations and reactions to an earthquake, i.e. there are differing Risk Management measures in each country exposed to such a risk. The marked difference is where the wealthier countries such as Japan and America take a more proactive approach to the threat as opposed to poorer nations like India and El Salvador who react to an earthquake. This is due mainly to limited finances restricting their ability to construct resistant buildings and roads. This difference is clearly evident in cases like Gujarat, India and Seattle, U.S.A., where earthquakes measuring 7.9 magnitude occurred in 2001. The death and destruction in India was overwhelming with experts estimating that the country will take 20 years to return to the state immediately prior to the earthquake (BBC News: 2001). In Seattle, America, the tremor was felt but no one was killed directly by the quake, although one heart-attack death was linked to the event (BBC News: 2001)

Experience

Experience also came out to be an important factor in the response to earthquake forecasts. Mileti et al. (1990) found that those with earthquake experience were more likely to respond to an earthquake warning or prediction.

Research has shown that there will be differences in people's responses to earthquake predictions and warnings depending on such variables as their previous disaster experience and their social and cultural characteristics. In psychology 'Comprehension Process' is where people draw upon their experiences, memory and expectations to attach meaning to a stimulus (Pidgeon, 1992). It is recognised that the response from the public will be more active amongst groups who are experienced with earthquakes, either by living through one or experiencing a prediction or warning (Anderson, 1970, Jackson, 1974)

Moore (1964) and Dynes (1970) proposed an explanation for such a strong response by experienced residents against future threats. They said that residents of an area exposed to recurring threats and disasters tend to build cultural defences. Farley et al. (1998) found that an 'earthquake subculture' existed close to the fault line in Missouri that resulted in a greater level of preparedness.

Yet Farley also found through his research that the link between earthquake experience and preparedness was not as strong as anticipated. He concluded that people are no more inclined to react to an earthquake if they have experienced one previously. He argued that it is whether or not the person believes the warning of the threat of an earthquake that will result in a reaction. It was found that public interest did not translate into actual personal preparedness.

Mulilis and Duval (1991) found sustained increases in preparedness following two damaging California earthquakes but only temporary increases following two minor quakes, this leads to the conclusion that people who have experienced a damaging earthquake may be more receptive to the idea of earthquake preparation.

It was suggested that the public does not want to be reminded of the dangers associated with future earthquake activity (Anon, 1978). Turner (1978) initiated a project to study the community response to the potential earthquake threat. The findings were strongly linked to the media's influence which is discussed later. What was evident was the rise and fall in preparedness of communities in relation to the occurrence of earthquakes. Slosson (1971) studied the number of earthquake-related bills introduced in the California Legislature and suggested that a strong emotional reaction prevails. He found that there is generally a lack of action during the lulls between disasters, accompanied by strong overreaction immediately following the disasters.

Would people move if they knew an earthquake was imminent?

This is inconclusive. It would appear from this study that the respondents in California were more aware of the threat of an earthquake but were less inclined to react by changing their lives dramatically. Residents in other areas such as New Zealand were far more likely to consider moving if a warning of an earthquake was issued. In Jackson's survey (1974), out of the 302

respondents, 177 of them were uncertain they would be affected by a future earthquake or denied the possibility outright.

Management of the Risk

If it were the case that experience indicates an increase in reaction and preparation towards the threat of earthquakes, the prospect of accurate prediction methods would be considered a great Risk Management method of early preparation for society. Yet **by exposing a community to the reality of an earthquake warning for their area, the process of experience may be more traumatic then experiencing a non-predicted quake** (National Research Council: 1978). It could result in a huge disaster. **New technology brings with it new risks.** What needs to be ensured is that earthquake prediction is reliable and trustworthy and will be used in the correct manner. Many scientists worry that inaccurate handling of such a new and uncertain technology could have greater detrimental consequences than advantages (National Research Council: 1978). Even communities who are experienced in living through earthquakes are not completely educated about the development of earthquake prediction. The benefits and the costs associated with mitigation efforts will be quite different from what they are when prediction is encountered without prior experience. (National Academy of Sciences: 1975)

The effect of communication

Communication is a fundamental aspect of any process and is especially apparent in Risk Management. To convey a message to others it must be done by various types of communication such as through an expert, the media or through government officials, to name but a few. Without good communication links, there will be poor Risk Management systems in place and this is a main cause of many disasters or needless panic.

Communication is a vital aspect in earthquake prediction. There is no use being able to predict the next earthquake, yet not have the communication links in place to inform the public in order for them to prepare. **Risk Communication can be defined as: "The exchange of information among interested parties about the nature, magnitude, significance or control of a risk**" (Covello et al., 1992: p 1), (National Research Council, 1989: p 79)

There is a fine line between communication and trust and credibility. These are what society looks for within others. Society especially looks for these traits in authoritative figures and bodies due to the fact that one person is not an expert in everything; they therefore have to put their faith in the knowledge of the experts. It is here that society must trust the expert's judgment and if their credibility is flawed, then this trust will not develop. Trust is a response based to some extent on a perception of credibility (Earle & Cvetkovich, 1998)

This study asked the survey respondents whom would they trust for information about earthquake prediction. The majority of respondents would trust the government and experts. What was surprising was the numbers stating they would not trust anyone and they would be happier educating themselves about earthquake prediction. Even more interesting was that the majority of respondents who did not trust the experts or the media were young students. Lipset and Schneider (1983) supported this finding that over the last two decades, experts and lay

people alike have claimed that trust in American institutions has diminished. Trust is much easier to destroy than to create or replace due to negative events being more prevalent and easier to recall than positive ones (Edelstein, 1987), (Slovic, 1993).

Society's trust in institutions could be affected by the internal conflicts between experts. The biggest hazard for the government and the experts when deciding whether to issue an earthquake prediction or warning is if they are correct. They are risking their reputations as being credible authorities and will rapidly loose the public's faith if incorrect. In Farley's study of the Browning prediction (1998), he found that much of the scientific community knew that the Browning prediction was false but did not react to the prediction for various reasons. They did not want to fuel the argument that already burned. By drawing attention to the subject they would be giving the prediction some credibility; by ignoring it, they hoped the problem would disappear. Scientists were also afraid to go against colleagues as it showed a lack of unity within the industry (Gori, 1993: p968). The Browning prediction is a good reference for this discussion as it highlighted the lack of Risk Management communication systems within the industry. There was no process or system to raise fears about the credibility of the prediction. The best way an entire body of educated scientists chose to deal with the false prediction was to ignore it until someone else took action. The official body, the National Earthquake Evaluation Council (NEPEC) released a statement which discredited Iben Browning's earthquake prediction in the mid west of America. They did this one month before the earthquake was due to take place according to Browning. At this time the public trusted Browning's prediction and they saw the rest of the industry as uncertain and incompetent. If there is confusion within the ranks of the professional, the lay person does not know whom to trust. As a result they believe what they want to believe or disregard all information and educate themselves.

Media influence

New information is learned by all through the media. The media communicate vital information, but unfortunately at the same time exaggerate stories to increase circulation figures. It is therefore not surprising that people state that they would trust the media as a source of accurate information. Apparently most of the public believe that they do not rely on the media for their information but actually find themselves dependent on this because there is no other source. Some media sources do uphold their responsibility to the community to inform, however they also use uncritical and incorrect reporting facts when informing the public about risky issues. When researching and reporting the predicted event, the media failed to check if Browning was a credible scientist or find other scientists who supported his prediction. Iben Browning had a Ph.D. in Zoology but had no formal training in seismology or climatology. Through the eyes of the media it was a good story which attracted overwhelming interest from the public. To doubt the validity of the prediction would be to kill the story. **The media thrives upon scare tactics and this event had all the correct ingredients.** These findings have also been found in studies by Turner et.al. (1986: p45-51).

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Lazarsfeld's two-step flow of communication (Lazarsfeld et.al; 1944) helped scientists understand the relationship between communicating information and human behaviour in response. It studied how the media was the public's main source of earthquake information. However, when deciding how to interpret the information and how to respond to it, the largest

influence was by family, friends and co-workers. (Katz; 1957), (Turner et al; 1986. p86). This suggested that the media is used in the decision making process but human interaction between trusted associates was found to have the most influential bearing on response to communication.

The Response of Society to the threat of an Earthquake Prediction

Each individual will react differently to a threatening situation, especially if they are informed in advance that a disaster is imminent. Yet personal thinking is generally influenced by the way other people think, feel and act, even without specifically trying to do so (Goodwin, 1992, Suls & Miller, 1977). The most persuasive yet subtle form of social influence is communicated through social norms. Norms are learned, socially based rules that prescribe what people should or should not do in various situations (Levine and Mooreland, 1995). Most people conform to these social norms and do not let their natural impulses be translated into overt behaviour. To be informed that a person's residential area will soon suffer a massive earthquake will be of great alarm, especially in inexperienced areas.

If the majority of the community decide to move out of the area either permanently or for the period of the prediction, there is statistical evidence stating that there will be a general shift that way and many people will follow the masses. Social norms are so powerful that people often follow them automatically. Influence and behaviour exerted by social norms do not always create orderly behaviour. It could lead to a breakdown in order. This situation is dangerous for earthquake prediction and one that could realistically occur. If a community is told they are facing a damaging earthquake, there could be a massive panic throughout the community. Public order could be lost.

People must decide if they believe the prediction which has been made. This has been studied by Farley (1998) who concluded that individuals rarely decide upon an action without consultation with others. There are many sources from which an individual will seek information and reassurance. Although the media is a main source of information that provided by friends, family and work colleagues is also a strong influence. Farley found that it is these groups of people whom the individual trusts most. If an individual's family or friends have decided to move out of the area, there is a far higher probability that they too will move. If their work colleagues are taking days off work to spend it with their children at home or in a place of safety, individuals are more likely to be influenced into changing their plans.

An area that was not prevalent in this study but proved by many other scientists is how a person's background can affect reactions. Farley's study in 1993 revealed that income and education are positively correlated with preparedness. White Anglos were more prepared than Hispanics or Afro-Americans. In 1975, the Field Research Corporation found that of the 1004 people interviewed 72% thought it was a good idea to warn the public of a forthcoming earthquake. Of these respondents it was the younger, educated and higher income that favored earthquake prediction than other groups. Of the respondents who did not favor earthquake prediction, 34% were aged 60+ (Weisbecker et al., 1977). Generally, lower levels of education have been associated with higher levels of threat-perception (Lazarus: 1966). There is a responsibility here for all levels of the educated public to be made aware of the implications of an earthquake prediction or warning. The media will play a fundamental role in the issuance of

this information as the media breaks down the complexities of the data and explains to society in simple terms. The largest response to earthquake preparedness in Farley's study came in the wake of a broadcast by NBC of the "Disaster Survival Test" in May 1977 to a large national audience (Farley: 1998). This heightened people's awareness of the potential implications of an earthquake. In reality, most failed the test and would face severe problems if a real earthquake did occur. As a result of the test, many people prepared for such an event.

Conclusions

Potentially destructive earthquakes occur so infrequently that many decades will pass before a method of accurate predictions becomes a reality. This article addressed the potential problems that the creation of a reliable forecasting technique for earthquakes could bring to society and whether it would mean that the way society deals with earthquakes and their consequences would change. Knowing that a devastating earthquake will definitely occur in a certain part of a country on a particular day has the potential to panic many people if not handled in a calm and organized manner.

There appears to be however many positive and negative effects an earthquake prediction can have upon a society. An earthquake affects many people at one time, is a natural disaster and is non-selective of who is affected. It is due to this that the implications of such a disaster will affect whole communities. There will undoubtedly be sociological and psychological effects to a society as these two subjects are the study of people and their reactions. People are social by nature, so their decisions are subject to social influences. Control measures for earthquakes have long been in place for physical prevention against them such as strengthening buildings. What is far from being implemented is the societal response to earthquake prediction. This study attempts to highlight areas that must be addressed if control is to be maintained once prediction becomes a reality. Experts, the authorities, the media and the public must all come together and plan for the inevitable day.

In order **for society to react to a prediction however they must firstly be informed about the threat and decide if the source is reliable.** It is only if they believe the source then they will react to the information and prepare for an earthquake. There are indeed many aspects which contribute to the sociological and psychological effects of earthquake prediction upon society. What is more interesting is the evidence that they are all interlinked. **There has always been a strong link between Risk Management and the physical risk of earthquakes, i.e. buildings collapsing, but there is now emerging a significant connection between earthquake forecasting and societal response to them. It will take a combination of social, technical, political and social strategies to be able to successfully manage the entire concept of earthquake prediction.**

The media has a large responsibility to play in the forecasting of earthquakes. It is the link between the public and the experts. It is the force behind distributing information about earthquake predictions and warnings. When the experts discover a way to accurately predict an earthquake, they will need the media to pass on the information. **The media will have a high responsibility to educate and inform society. Yet it could be the media that could cause widespread panic about a prediction. The threat of a repeat media performance like the**

Browning prediction (Farley, 1998), could cause massive panic and large distrust towards the experts. The media is also the link in raising awareness of earthquakes and their mitigation. Communication links must be improved and a two-way flow of information be adopted.

Attitudes towards the government and the experts have changed. **Society is more questioning of the information provided. A trend is emerging that the younger generation would rather educate themselves rather than trust the authorities' judgment about earthquake prediction.** Once earthquake forecasting becomes a reality, governments must be aware of the diminishing trust of younger generations. They should be careful to consider the implications for a community and involve key members of society in the decision making process before a way forward is agreed.

Risk Management is a vital component in the strategies for preparedness for earthquakes. It provides systems and action plans to follow. It helps all parties communicate and share information. Good management enables people to focus on the preventative methods they need to adopt in order to be best prepared for such a disaster. By using adequate, coherent and a continuing Risk Management plan of hazard reduction and disaster preparedness, societies will be ready for such an event. Officials must take responsibility for this planning and implementing stage, but public participation is also imperative. It will require the co-operation of scientists, public officials and the media to provide understandable and realistic interpretations of all reported predictions.

References:

1. Adams, R. (1975), The Haicheng Earthquake of 4 February 1975: the first successfully predicted earthquake. Earthquake Engineering and Structural Dynamics 4, 423 – 37.
2. Alexander, D. (1998), Natural Disasters, London, UCL Press
3. Anderson, W.A. (1970), "Tsunami Warning in Cresent City, California, and Hilo, Hawaii, " The Great Alaska Earthquake of 1964: Human Ecology, Committee on the Alaska Earthquake, National research Council (Washington, DC: National Academy of Sciences, 1970), pp116 – 124.
4. Anon (1978), The Public wants to be Informed, Nat. Haz. Observer, 2, 2.
5. BBC News (2000), Britain braced for more heavy rains. Available at: http://www.co.uk/hi/english/world/eurpoe/newsid_108000/1008119.stm accessed 02/04/01, written 21/11/00.
6. BBC News (2001), Can money stop an earthquake? Available at: http://www.bbc.co.uk/hi/english/world/americas/newsid_1196000/1196017.stm accessed 01/03/01, written 02/04/01.
7. BBC News (2001), The cost of India's Quake, Available from: http://www.bbc.co.uk/hi/english/business/newsid_1142000/1142449.stm Accessed 04/04/01, Written 02/02/01.
8. Berlin, G. L. (1980), Earthquakes and the Urban Environment, CRC Press: Florida, Volume Three.
9. Berren, M.R. et al.(1982), "A Typology for the Classification of Disasters: Implications for Intervention, Community Mental Health Journal, 18 (2): 120-34
10. Blaxter, L. et al. (1997), How to Research, Open University Press: England.

11. Blundell, D.J. (1977), Living with Earthquakes, Disasters 1, 41 –6.
12. Bolin, R. & Stanford, L. (1998), The Northridge Earthquake; Vulnerability and Disaster, London: Routledge.
13. Brown, L. (1996), ‘ The Acceleration of History’, in L. Brown (ed.) State of \the World 1996, New York: Norton.
14. Committee on Socioeconomic effects of Earthquake Predictions (1975),, A Program of studies on the Socioeconomic effects of earthquake Predictions, National Research Council Washington D.C: National Academy of Sciences
15. Committee on Socioeconomic effects of Earthquake Predictions (1978) A Program of studies on the Socioeconomic effects of earthquake Predictions, National Research Council, Washington D.C: National Academy of Sciences
16. Covello, V. T. (1992), “Trust & Credibility in Risk Communication”, Health Environment Digest. 6(1), 1-3.
17. Department of the Environment (1993), Earthquake Hazard and Risk in the U.K..
18. Dynes, R.R. (1970), Organised Behaviour in Disaster (Lexington, Mass.: D.C. Health, p92.
19. Earle, T. & Cvetkovich, G. (1998), “Determining the Determinants of Trust”, Risk Analysis, 18, No.3, 231-34.
20. Eiby, G.A. (1980), Earthquakes, New Zealand: Heinemann
21. Edelstein (1987), Cited in, Pidgeon, N.F. et al. (1992), “Risk Perception”, Royal Society. Farley, J.E. et al. (1991), Earthquake Hysteria, Before and After: A Survey and Follow-up on Public Response to the Browning Forecast, Department of Sociology and Social Work, Southern Illinois University at Edwardsville, USA.
22. Farley, J.E. (1998), Down but not out: Earthquake awareness and Preparedness Trends in the St. Louis Metropolitan Area, 1990 – 1997, Guest Editor in International Journal of Mass Emergencies and Disasters, Vol 16, No 3, pp303 – 319.
23. Farley, J. E. (1998), Earthquake Fears, Predictions, and Preparations in Mid-America, Southern Illinois University Press: Illinois
24. Festinger, L. (1954), “A theory of social comparison processes.” Human Relations, 7, 117-140.
25. Flynn, J. et al. (1999), ‘ Public Support for Earthquake Risk Mitigation in Portland, Oregon, from Risk Analysis, Volume 19, No 2, pp205 – 216
26. Giori, p. (1993), “The Social Dynamics of a False Earthquake Prediction and the Response by the Public Sector.” Bulletin of the Seismological Society of America, No. 83: 963 – 80.
27. Goodwin, C. (1992), “A conceptualization of Motives to Seek Privacy for the Nondeviant consumption”, Journal of Consumer Psychology, 1, pp261 – 284.
28. Gunn, S. W. A. (1995), ‘Health Effects of Earthquakes’, from Disaster Prevention and Management, Volume 4, Number 5, pp 2 – 9
29. Haicheng Earthquake Study Delegation (1977), Prediction of the Haicheng Earthquake Prediction, China EOS: American Geophysical Union Transactions, 58, p 236-72.
30. Jackson, E.L. (1974), Response to Earthquake Hazard: Factors related to the Adoption of Adjustments by Residents of Three Earthquake Areas of the West Coast of North America, Ph. D. thesis, Department of Geography, University of Toronto, Canada.
31. Jackson, E.L. (1977), Public Response to Earthquake Hazard, Calif. Geol., 30, 278.

32. Janis, I.L. (1972), Groupthink: Psychological studies of policy decisions and fiascoes, Boston: Houghton Mifflin, (2nd ed.).Jones, S., (1985), 'Depth Interviewing', in R. Walker (ed.), Applied Qualitative Research, Gower: Aldershot.
33. Katz, E. (1957), "The Two-Step Flow of Communication: an Up-to-Date Report on a Hypothesis." Public Opinion Quarterly, Vol 21, 61 – 78.
34. Laserfeld, P.F. et al. (1944), Psychological Stress and the Coping Process, New York: Mcgraw-Hill.
35. Latane, B. & Wolf, S. (1981), "The social impact of majorities and minorities.", Psychological Review, 88, 438-453.
36. Levine, J.M. & Moreland, R.L. (1995), "Group Processes". In A Turner (Ed), Advanced Social Psychology, New York: McGraw-Hill, pp 419 – 466.
37. Lipset & Schneider (1985), Cited in Pidgeon, N.F. et al. (1992), "Risk Perception", Royal Society.
38. McLuckie, B.F. (1973), The Warning System: A Social Science Perspective, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C.: U.S. Government Printing Office, p22.
39. Milet, D. & Krane, S. (1973), Countdown to the Unlikely, Paper presented at the annual meeting of the American Sociological Association, New York City.
40. Mileti, D.S. et al. (1990), Risk Communication and Public Response to the Parkfield Earthquake Prediction Experiment. Final Report to the National Science Foundation. Fort Collins: Colorado State University, Hazards Assessment Laboratory and Department of Sociology.
41. Moore, H.E. (1964)……and the Winds Blew (Austin: Hogg Foundation for Mental Health, University of Texas Press, pp 195 – 213.
42. Mulilis, J.P. & Duval, T.S., (1991), The Impact of Nearby Earthquakes on Individual Earthquake Preparedness. Paper Presented at the UCLA International Conference on the Impact of Natural Disasters, Los Angeles, July 9-12.
43. Nat Research Council (1989), Cited in, Pidgeon, N.F. et al. (1992), "Risk Perception", Royal Society.
44. OES (California Governor's Office of Emergency Services) (1997) The Northridge Earthquake of January 17, 1994: Report of Data Collection and Analysis, Part B: Analysis and Trends, Irvine and Pasadena: EQE International and Office of Emergency Services.
45. Panel on the Public Policy Implications of Earthquake Prediction of the Advisory Committee on Emergency Planning (1975), Commission on Sociotechnical Systems, National Research Council, Washington D.C.: National Academy of Sciences.
46. Paton, D. (1994), 'The Psychosocial Aspects of Managing Chronic Environmental Disaster', from Disaster Management, Volume 6 Number 1, pp 13 – 18
47. Pidgeon, N. et al. (1992). Risk Perception. Royal Society, Chapter 5, pp 92.
48. Prentice-Dunn, S. & Rogers, R.W. (1989), "Deindividuation and the self-regulation of behavior. In P.B. Paulus (Ed.), Psychology of Group Influence, (2nd ed.), Hillsdale, NJ: Lawrence Erlbaum Associates.
49. Readers Digest (1995), Nature's Masterpieces, The Reader's Digest Association Limited: London.
50. Sachanski, S. (1987), 'Buildings: Codes, materials, design', in The assessment and mitigation of earthquake risk, (1978), Unesco: Ghent

51. Sharp, J.A. & Howard, K. (1998), The Management of a Student Research Project, (2nd ed.), Gower: London, pp87, figure 4.3
52. Shoaf, K. et al. (1998), 'Injuries as a Result of California Earthquakes in the Past Decade', from Disasters, Volume 22, Number 3, pp 218 – 235
53. Solway, L. (1994), 'Urban Developments and Megacities: Vulnerability to Natural
54. Southwick, C. (1996), Global Ecology in Human Perspective, New York: Oxford University Press
55. Sullivan, R. et al. (1977), Living in earthquake country, a summary of residents living along the San Andreas fault, Calif. Geol., 30, 3.
56. Tazieff, H. (1989), Earthquake Prediction, Hachette: Paris, France
57. Tetlock, P.E. (1985), "Accountability: The neglected social context of judgement and choice. Research in Organisational Behavior, 7, 297-332.
58. Tobin, G., & Montz, B. (1997), Natural Hazards: Explanation and Integration, New York: Guilford.
59. Slosson, J.E. (1975), Legislation related to earthquakes, Calif. Geol., 28, 37. In G. Lennis Berlin (1980), California earthquake legislation and percentage of bills passed into law, Earthquakes and the Urban Environment, CRC Press: Florida, Volume Three, Page 74, Figure 1.
60. Slovic, P. (1993), "Perceived Risk, Trust and Democracy." Risk Analysis, Vol 13, No. 6, 675 – 682)
61. Stoner, J.A.F. (1961), A comparison of individual and group decisions involving risk. Unpublished master's thesis, Massachusetts Institute of Technology.
62. Suls, J. &Miller, R. (Eds.) (1977), Social comparison processes: Theoretical and Empirical Perspectives. Washington D.C.: Hemisphere Publishing Corporation.
63. Turner, R. (1978), Prediction of the Haicheng earthquake, mobilising the masses, EOS Trans. Am. Geophys, Union, 58, 260.
64. Turner, R.H. et al. (1986), Waiting for Disaster: Earthquake Watch in California. Berkeley: University of California Press.
65. Wesbecker et al. (1977), Earthquake Prediction, Uncertainty, and Policies for the Future, Stanford Research Institute, Menlo Park, California.

Answer Key for Writing Assignment

It briefly examines the psychological and sociological effects that an earthquake prediction can have upon a society, society's reaction to such a prediction, how experience can effect this reaction, the media's role in communicating and influencing the prediction, the level of trust society has in the experts and the government in their communication of risk and the denial of earthquake risk where lifestyle and standard of living outweighs it. In addition, by combining and contrasting evidence, this study highlights the role that Risk Management plays in this issue. The key points to be emphasized are highlighted in bold in the text below.

Earthquake Risk Prediction

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Earthquakes

Earthquakes are considered to be one of the most dangerous of all natural disasters, mainly due to the sudden-impact they bring with hardly any forewarnings (Alexander, 1998). They are 10 times more destructive than any other natural hazard and they should be prepared for (Eiby, 1980).

The earth's crust is divided into seven moving plates and the biggest and most frequent events occur in zones close to the seven plates' boundaries. In California, the San Andreas Fault is where the Pacific and North American Plates slide past each other. It is not a smooth and continuous process and these two plates are mostly locked together by friction. When pressure builds to a certain point, resistance becomes too great and the plates lurch along their predicted paths and an earthquake occurs (Reader's Digest, 1998). It is a powerful force of nature and there is nothing man can do to prevent earthquakes from occurring. The best man can do is observe and record the earth's movements and apply gained knowledge to early warnings.

The global number of natural disasters has been increasing over the course of the 20th Century although the aggregate number of natural hazard events such as earthquakes, flooding and tornadoes generally has not (Tobin & Montz, 1997). This could suggest that human influences are involved in determining the scale of a natural disaster. World population is now reaching 6 billion people which means it has tripled this century (Southwick, 1996). The global economy production has quintupled since 1950 (Brown, 1996) and there are 4 billion more people now variously exposed to environmental hazards than there were in 1900. The consequence of a

natural event perhaps would not be so great if these 4 billion people were housed in well-planned communities and had economic stability, but this will probably never be the case.

Earthquake Prediction

It would be of great benefit to society if it could know when a disaster will strike and it is ironic that the most destructive natural hazard is also the least understood. The 19th century was the Golden age for all studies to do with the earth and in this time the invention of the seismograph by John Milne (1850-1913) took place that gave society the ability to analyze earthquakes. Scientists now feel close to unveiling a sound method of prediction and there is a belief that it will be a reality in the near future however, the pieces do not yet quite fit together.

A comprehensive earthquake prediction should specify the location of the event, the geographical area likely to be affected, the time interval during which the event is expected to occur, the expected magnitude range of the tremors, and other physical parameters. Any prediction however will not be 100% accurate however and this is due to the "confidence level representing the percentage of likelihood that the earthquake will occur as predicted" (Alexander, 1998, p 58).

There have been earthquake predictions made in the past; the most famous being that in Haicheng in China on the 4th February 1975 (Adams, 1975). This was done by a combination of instrumental monitoring and observation of foreshocks. A mass evacuation program was launched and in those few hours many thousands of lives were saved before a devastating earthquake of 7.3 magnitude shook 22 million m2 of the city. The death toll stood at 1,328 and 16,980 injured (Haicheng Earthquake Study Delegation, 1977). This was an extremely low figure considering the location was in a densely populated area. The Haicheng prediction still remains the only large-scale accurate prediction made, even though the Chinese have claimed that at least ten earthquake predictions have been successfully predicted since 1975 with magnitudes of 6.5 and above (Blundell, 1977).

Today, there are promising signs that accurate predictions might be made in the future with the use of space technology. It seems that by looking down to the earth with specialized machinery, more data can be gathered as to the state of the tectonic plates and the pressure of each can be measured to indicate if an earthquake should be expected. However, no significant prediction, thus far, has been made from this method. The VAN method is where various stations in an area pick up SES – Seismic Electrical Signals discovered by physicists Varotos, Alexopoulos and Nomikos. During 1988-89, they made 17 accurate predictions in various locations each measuring a significant magnitude. It was the exactness of the location, time and magnitude of the predictions that excited scientists. There still remains uncertainty, however, and much depends on the accuracy of the stations receiving the signals. Only if these stations can give accurate readings can the rest of the process be 100% certain (Tazieff, 1989: p85).

It must be remembered that the main purpose of earthquake forecasting is to reduce loss of life and damage to property by allowing time for preparation (Alexander, 1998). A falsely made prediction could cause panic and unnecessary disruption to many lives. This was the case when in December 1990 when Iben Browning made a pseudoscientific prediction (unfounded upon

scientific fact). This prediction was inaccurate and had serious detrimental implications in the New Madrid Seismic Zone in mid-America.

Risk Management in Earthquake Prediction

There are always risks facing society; it is how we mitigate these risks, which is the real skill. Even in Great Britain societal risks exist. The country has suffered many man-made disasters in the past affecting many lives. Events all too familiar to the public are the Piper Alpha Oil Platform fire (1988), the Exxon Valdez pollution (1989) and the rail accidents such as Clapham (1988) and Paddington (1999). However natural disasters are much less frequent. Britain would class flooding as a potentially more devastating hazard than earthquakes but the risk of earthquake does exist. There is a known fault down the middle of the Atlantic stretching towards Iceland (Department of the Environment, 1993). This risk is not high and the country should probably never feel the full force of an earthquake but because of this, the population, government and buildings are ill prepared for any disaster.

Natural disasters in essence cannot be prevented and Risk Management techniques for this sort of risk are that of the mitigation of the consequences rather than prevention of the event itself. There is obvious difficulty in quantifying the risk of an earthquake, however, with prediction society could know roughly what to expect and make provisions for the type of earthquake forecasted. Schools could be closed, buildings re-enforced and the public educated as to how to react to the actual tremor and the damage it will cause.

In an area such as California, everyone knows that the threat of earthquake exists and is high, because of past events. A weak prediction has been made in California by scientists stating that some time in the next few decades a massive earthquake will occur. It is not known when or where specifically, but the way it will happen and the effects are known. It is commonly termed ‘The Big One’, the official term for it is ‘a standing prediction’ (National Research Council, 1978). It has been predicted that the two main cities; Los Angeles (L.A.) or San Francisco could be hardest hit with the potential for either to fall into the sea. If this were to happen it would result in massive loss of life and property and affect the world, as California is a significant contributor to the world’s economy.

To those living away from these areas it may be puzzling as to why these areas are so desirable if the risk is so great. It is here that we see the conflict between risk and benefits. Most residents in California have a high standard of living and enjoy a consistently good climate. Therefore residents choose to live with the risk of earthquakes. Many argue that because the risk cannot be seen or predicted accurately it is something of a myth and many do not even bother to consider the potential devastation of a quake. It is also seen as impractical to prepare adequately for a prediction, as measures such as knocking down hazardous buildings would be too costly. The best prediction a community could get is advanced warning of around 2 years together with an assurance of the location and magnitude (National Research Council, 1975). This would give adequate time for all residents to be made aware of the threat and to make reasonable preparations.

In 1994 an unknown fault released enough energy to cause an earthquake of magnitude 6.7. It occurred under the suburban town of Northridge in the San Fernando Valley, North L.A. It caused 57 deaths and was classed as one of the most expensive disasters in US history with losses of $25 billion and estimated losses reaching $44 billion (OES: 1997). In the HAZUS 99 report into the Average Annual Earthquake Losses for the United Sates complied by FEMA, it claimed that losses in the U.S. add up to around $4.4 billion per year with 84% of the losses occurring in California, Washington and Oregon. California State's losses alone amount to $3.3 billion of the total (Bolin & Stanford: 1998)

The mitigation of earthquake risk varies in each country. There is a large split between the efforts in developed countries and those in developing countries. The recent earthquakes in El Salvador and India (2001) that happened less than a month apart show this. Both these quakes were significant in magnitude and brought numerous casualties – the India earthquake measured 7.9 magnitude and hit in the heart of a city claiming the lives of an estimated 20,000. The Indian earthquake measured the same magnitude as the recent Seattle earthquake (2001). The most alarming fact to come of the comparison is that there was only one casualty as a result of the Seattle Earthquake. He died from a heart attack (BBC News, 2001). It is clear from the death tolls that the West Coast of America has developed cities with earthquake hazard in mind. This could be due to California knowing there will be a devastating quake someday, or that their economy and land management is better planned. It must be remembered that the highest priority in responding to earthquake prediction is to save lives, with secondary attention to minimizing the social and economic disruption and property loss. (National Academy of Sciences, 1979).

This paper acknowledges the many ways **Risk Management can be used to mitigate earthquake risk. Many studies of earthquake risk focus upon the physical techniques that can be used to reduce the risk of harm caused by an earthquake. This can be evidenced by the continual upgrading and renewing of engineering methods to make structures more secure in areas subject to earthquakes. This article puts forward the following conclusions.**

A Nation's Wealth

What appears to have developed are different preparations and reactions to an earthquake, i.e. there are differing Risk Management measures in each country exposed to such a risk. The marked difference is where the wealthier countries such as Japan and America take a more proactive approach to the threat as opposed to poorer nations like India and El Salvador who react to an earthquake. This is due mainly to limited finances restricting their ability to construct resistant buildings and roads. This difference is clearly evident in cases like Gujarat, India and Seattle, U.S.A., where earthquakes measuring 7.9 magnitude occurred in 2001. The death and destruction in India was overwhelming with experts estimating that the country will take 20 years to return to the state immediately prior to the earthquake (BBC News: 2001). In Seattle, America, the tremor was felt but no one was killed directly by the quake, although one heart-attack death was linked to the event (BBC News: 2001)

Experience

Experience also came out to be an important factor in the response to earthquake forecasts. Mileti et al (1990) found that those with earthquake experience were more likely to respond to an earthquake warning or prediction.

Research has shown that there will be differences in people's responses to earthquake predictions and warnings depending on such variables as their previous disaster experience and their social and cultural characteristics. In psychology 'Comprehension Process' is where people draw upon their experiences, memory and expectations to attach meaning to a stimulus (Pidgeon, 1992). It is recognised that the response from the public will be more active amongst groups who are experienced with earthquakes, either by living through one or experiencing a prediction or warning (Anderson, 1970, Jackson, 1974)

Moore (1964) and Dynes (1970) proposed an explanation for such a strong response by experienced residents against future threats. They said that residents of an area exposed to recurring threats and disasters tend to build cultural defences. Farley et al (1998) found that an 'earthquake subculture' existed close to the fault line in Missouri that resulted in a greater level of preparedness.

Yet Farley also found through his research that the link between earthquake experience and preparedness was not as strong as anticipated. He concluded that people are no more inclined to react to an earthquake if they have experienced one previously. He argued that it is whether or not the person believes the warning of the threat of an earthquake that will result in a reaction. It was found that public interest did not translate into actual personal preparedness.

Mulilis and Duval (1991) found sustained increases in preparedness following two damaging California earthquakes but only temporary increases following two minor quakes, this leads to the conclusion that people who have experienced a damaging earthquake may be more receptive to the idea of earthquake preparation.

It was suggested that the public does not want to be reminded of the dangers associated with future earthquake activity (Anon, 1978). Turner (1978) initiated a project to study the community response to the potential earthquake threat. The findings were strongly linked to the media's influence which is discussed later. What was evident was the rise and fall in preparedness of communities in relation to the occurrence of earthquakes. Slosson (1971) studied the number of earthquake-related bills introduced in the California Legislature and suggested that a strong emotional reaction prevails. He found that there is generally a lack of action during the lulls between disasters, accompanied by strong overreaction immediately following the disasters.

Would people move if they knew an earthquake was imminent?

This is inconclusive It would appear from this study that the respondents in California were more aware of the threat of an earthquake but were less inclined to react by changing their lives dramatically. Residents in other areas such as New Zealand were far more likely to consider moving if a warning of an earthquake was issued. In Jackson's survey (1974), out of the 302

respondents, 177 of them were uncertain they would be affected by a future earthquake or denied the possibility outright.

Management of the Risk

If it were the case that experience indicates an increase in reaction and preparation towards the threat of earthquakes, the prospect of accurate prediction methods would be considered a great Risk Management method of early preparation for society. Yet **by exposing a community to the reality of an earthquake warning for their area, the process of experience may be more traumatic then experiencing a non-predicted quake** (National Research Council: 1978). It could result in a huge disaster. **New technology brings with it new risks.** What needs to be ensured is that earthquake prediction is reliable and trustworthy and will be used in the correct manner. Many scientists worry that inaccurate handling of such a new and uncertain technology could have greater detrimental consequences than advantages (National Research Council: 1978). Even communities who are experienced in living through earthquakes are not completely educated about the development of earthquake prediction. The benefits and the costs associated with mitigation efforts will be quite different from what they are when prediction is encountered without prior experience. (National Academy of Sciences: 1975)

The effect of communication

Communication is a fundamental aspect of any process and is especially apparent in Risk Management. To convey a message to others it must be done by various types of communication such as through an expert, the media or through government officials, to name but a few. Without good communication links, there will be poor Risk Management systems in place and this is a main cause of many disasters or needless panic.

Communication is a vital aspect in earthquake prediction. There is no use being able to predict the next earthquake, yet not have the communication links in place to inform the public in order for them to prepare. **Risk Communication can be defined as: "The exchange of information among interested parties about the nature, magnitude, significance or control of a risk**" (Covello et al., 1992: p 1), (National Research Council, 1989: p 79)

There is a fine line between communication and trust and credibility. These are what society looks for within others. Society especially looks for these traits in authoritative figures and bodies due to the fact that one person is not an expert in everything; they therefore have to put their faith in the knowledge of the experts. It is here that society must trust the expert's judgment and if their credibility is flawed, then this trust will not develop. Trust is a response based to some extent on a perception of credibility (Earle & Cvetkovich, 1998)

This study asked the survey respondents whom would they trust for information about earthquake prediction. The majority of respondents would trust the government and experts. What was surprising was the numbers stating they would not trust anyone and they would be happier educating themselves about earthquake prediction. Even more interesting was that the majority of respondents who did not trust the experts or the media were young students. Lipset and Schneider (1983) supported this finding that over the last two decades, experts and lay

people alike have claimed that trust in American institutions has diminished. Trust is much easier to destroy than to create or replace due to negative events being more prevalent and easier to recall than positive ones (Edelstein, 1987), (Slovic, 1993).

Society's trust in institutions could be affected by the internal conflicts between experts. The biggest hazard for the government and the experts when deciding whether to issue an earthquake prediction or warning is if they are correct. They are risking their reputations as being credible authorities and will rapidly loose the public's faith if incorrect. In Farley's study of the Browning prediction (1998), he found that much of the scientific community knew that the Browning prediction was false but did not react to the prediction for various reasons. They did not want to fuel the argument that already burned. By drawing attention to the subject they would be giving the prediction some credibility; by ignoring it, they hoped the problem would disappear. Scientists were also afraid to go against colleagues as it showed a lack of unity within the industry (Gori, 1993: p968). The Browning prediction is a good reference for this discussion as it highlighted the lack of Risk Management communication systems within the industry. There was no process or system to raise fears about the credibility of the prediction. The best way an entire body of educated scientists chose to deal with the false prediction was to ignore it until someone else took action. The official body, the National Earthquake Evaluation Council (NEPEC) released a statement which discredited Iben Browning's earthquake prediction in the mid west of America. They did this one month before the earthquake was due to take place according to Browning. At this time the public trusted Browning's prediction and they saw the rest of the industry as uncertain and incompetent. If there is confusion within the ranks of the professional, the lay person does not know whom to trust. As a result they believe what they want to believe or disregard all information and educate themselves.

Media influence

New information is learned by all through the media. The media communicate vital information, but unfortunately at the same time exaggerate stories to increase circulation figures. It is therefore not surprising that people state that they would trust the media as a source of accurate information. Apparently most of the public believe that they do not rely on the media for their information but actually find themselves dependent on this because there is no other source. Some media sources do uphold their responsibility to the community to inform, however they also use uncritical and incorrect reporting facts when informing the public about risky issues. When researching and reporting the predicted event, the media failed to check if Browning was a credible scientist or find other scientists who supported his prediction. Iben Browning had a Ph.D. in Zoology but had no formal training in seismology or climatology. Through the eyes of the media it was a good story which attracted overwhelming interest from the public. To doubt the validity of the prediction would be to kill the story. **The media thrives upon scare tactics and this event had all the correct ingredients.** These findings have also been found in studies by Turner et.al. (1986: p45-51).

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Lazarsfeld's two-step flow of communication (Lazarsfeld et.al; 1944) helped scientists understand the relationship between communicating information and human behaviour in response. It studied how the media was the public's main source of earthquake information. However, when deciding how to interpret the information and how to respond to it, the largest

influence was by family, friends and co-workers. (Katz; 1957), (Turner et al; 1986. p86). This suggested that the media is used in the decision making process but human interaction between trusted associates was found to have the most influential bearing on response to communication.

The Response of Society to the threat of an Earthquake Prediction

Each individual will react differently to a threatening situation, especially if they are informed in advance that a disaster is imminent. Yet personal thinking is generally influenced by the way other people think, feel and act, even without specifically trying to do so (Goodwin, 1992, Suls & Miller, 1977). The most persuasive yet subtle form of social influence is communicated through social norms. Norms are learned, socially based rules that prescribe what people should or should not do in various situations (Levine and Mooreland, 1995). Most people conform to these social norms and do not let their natural impulses be translated into overt behaviour. To be informed that a person's residential area will soon suffer a massive earthquake will be of great alarm, especially in inexperienced areas.

If the majority of the community decide to move out of the area either permanently or for the period of the prediction, there is statistical evidence stating that there will be a general shift that way and many people will follow the masses. Social norms are so powerful that people often follow them automatically. Influence and behaviour exerted by social norms do not always create orderly behaviour. It could lead to a breakdown in order. This situation is dangerous for earthquake prediction and one that could realistically occur. If a community is told they are facing a damaging earthquake, there could be a massive panic throughout the community. Public order could be lost.

People must decide if they believe the prediction which has been made. This has been studied by Farley (1998) who concluded that individuals rarely decide upon an action without consultation with others. There are many sources from which an individual will seek information and reassurance. Although the media is a main source of information that provided by friends, family and work colleagues is also a strong influence. Farley found that it is these groups of people whom the individual trusts most. If an individual's family or friends have decided to move out of the area, there is a far higher probability that they too will move. If their work colleagues are taking days off work to spend it with their children at home or in a place of safety, individuals are more likely to be influenced into changing their plans.

An area that was not prevalent in this study but proved by many other scientists is how a person's background can affect reactions. Farley's study in 1993 revealed that income and education are positively correlated with preparedness. White Anglos were more prepared than Hispanics or Afro-Americans. In 1975, the Field Research Corporation found that of the 1004 people interviewed 72% thought it was a good idea to warn the public of a forthcoming earthquake. Of these respondents it was the younger, educated and higher income that favored earthquake prediction than other groups. Of the respondents who did not favor earthquake prediction, 34% were aged 60+ (Weisbecker et al., 1977). Generally, lower levels of education have been associated with higher levels of threat-perception (Lazarus: 1966). There is a responsibility here for all levels of the educated public to be made aware of the implications of an earthquake prediction or warning. The media will play a fundamental role in the issuance of

this information as the media breaks down the complexities of the data and explains to society in simple terms. The largest response to earthquake preparedness in Farley's study came in the wake of a broadcast by NBC of the "Disaster Survival Test" in May 1977 to a large national audience (Farley: 1998). This heightened people's awareness of the potential implications of an earthquake. In reality, most failed the test and would face severe problems if a real earthquake did occur. As a result of the test, many people prepared for such an event.

Conclusions

Potentially destructive earthquakes occur so infrequently that many decades will pass before a method of accurate predictions becomes a reality. This article addressed the potential problems that the creation of a reliable forecasting technique for earthquakes could bring to society and whether it would mean that the way society deals with earthquakes and their consequences would change. Knowing that a devastating earthquake will definitely occur in a certain part of a country on a particular day has the potential to panic many people if not handled in a calm and organized manner.

There appears to be however many positive and negative effects an earthquake prediction can have upon a society. An earthquake affects many people at one time, is a natural disaster and is non-selective of who is affected. It is due to this that the implications of such a disaster will affect whole communities. There will undoubtedly be sociological and psychological effects to a society as these two subjects are the study of people and their reactions. People are social by nature, so their decisions are subject to social influences. Control measures for earthquakes have long been in place for physical prevention against them such as strengthening buildings. What is far from being implemented is the societal response to earthquake prediction. This study attempts to highlight areas that must be addressed if control is to be maintained once prediction becomes a reality. Experts, the authorities, the media and the public must all come together and plan for the inevitable day.

In order **for society to react to a prediction however they must firstly be informed about the threat and decide if the source is reliable.** It is only if they believe the source then they will react to the information and prepare for an earthquake. There are indeed many aspects which contribute to the sociological and psychological effects of earthquake prediction upon society. What is more interesting is the evidence that they are all interlinked. **There has always been a strong link between Risk Management and the physical risk of earthquakes, i.e. buildings collapsing, but there is now emerging a significant connection between earthquake forecasting and societal response to them. It will take a combination of social, technical, political and social strategies to be able to successfully manage the entire concept of earthquake prediction.**

The media has a large responsibility to play in the forecasting of earthquakes. It is the link between the public and the experts. It is the force behind distributing information about earthquake predictions and warnings. When the experts discover a way to accurately predict an earthquake, they will need the media to pass on the information. **The media will have a high responsibility to educate and inform society. Yet it could be the media that could cause widespread panic about a prediction. The threat of a repeat media performance like the**

Browning prediction (Farley, 1998), could cause massive panic and large distrust towards the experts. The media is also the link in raising awareness of earthquakes and their mitigation. Communication links must be improved and a two-way flow of information be adopted.

Attitudes towards the government and the experts have changed. **Society is more questioning of the information provided. A trend is emerging that the younger generation would rather educate themselves rather than trust the authorities' judgment about earthquake prediction.** Once earthquake forecasting becomes a reality, governments must be aware of the diminishing trust of younger generations. They should be careful to consider the implications for a community and involve key members of society in the decision making process before a way forward is agreed.

Risk Management is a vital component in the strategies for preparedness for earthquakes. It provides systems and action plans to follow. It helps all parties communicate and share information. Good management enables people to focus on the preventative methods they need to adopt in order to be best prepared for such a disaster. By using adequate, coherent and a continuing Risk Management plan of hazard reduction and disaster preparedness, societies will be ready for such an event. Officials must take responsibility for this planning and implementing stage, but public participation is also imperative. It will require the co-operation of scientists, public officials and the media to provide understandable and realistic interpretations of all reported predictions.