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DEVELOPMENT OF SEISMIC SAFETY DURING PRE- AND CO-SEISMIC PERIODS

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ABSTRACT

Since the year 2000 a large number of earthquakes have taken place. But despite advances in disaster management and seismology, till now it has not been possible to save a single life during earthquake. Issue of forewarning based on reliable seismic precursors has not been considered. Large magnitude earthquakes in India, Indonesia, Pakistan, Iran, China, Italy, and Peru etc were unexpected jolts to the disaster managers. Practically each earthquake has taken heavy death toll in India, Pakistan, Iran, and China etc. If some precursory warning were issued, it would help in saving at least some lives. The issue of earthquake prediction is tricky and considering the present status of the subject, no government would predict earthquake. Whether the government predicts or not, after the occurrence of a destructive earthquake, the administration would always be in the dock. To overcome the situation, earthquake education for the masses should be so powerful that they would draw their own inference about occurrence or non-occurrence of an earthquake.

INTRODUCTION

It is always said that earthquakes do not kill anybody but it is the collapse of the man made structures, which kill men. For last fifty years or so there has been remarkable progress in the fields of earthquake engineering, structural design and seismological instrumentation. On the other hand the progress in theoretical seismology during last fifty years is also remarkable. Last twenty years have seen good progress in the field of earthquake prediction.

Bernars (1997), Bapat (2007), Friedemann (2006), Keilis-Borok (2002), Lomnitz (1994), Rikitake (1984) have discussed various aspects of earthquake prediction. On the other hand Geller et. al (1997) have observed that earthquake cannot be predicted. The subject of earthquake prediction is still having a big question mark. After every destructive earthquake, there are innumerable technical reports and earthquake survey reports describing a large number of earthquake precursors. But the studies and observations about earthquake precursors have not reached a matured level. As such in some countries, common man or any scientist is not authorized to publicly announce any earthquake prediction. In Japan, only the Japanese Prime Minister could announce earthquake prediction. In India, wrong prediction is culpable offence and a person who does such prediction can be tried in court. The present situation appears to be skew. On one side, a large number of seismologists are coming forward with huge data about reliable seismic precursors and on the other side, disaster managers say and perhaps they are of the considered opinion that earthquake cannot be predicted. Both want to save lives. This is possible if their lines of thinking are not skew. This situation has to be overcome. Lack of seismic awareness is the root cause of the earthquake induced Sumatran tsunami of 26 Dec 2004. Locations like Thailand and Andaman Island had about 15 to 35 minutes interval available to issue warning. The time duration corresponds to origin time of earthquake and tsunami waves hitting the coastal regions in Thailand and Andaman. Similarly, India and Sri Lanka had about 115 to 140 minutes, which could have been utilized for issue of warning and evacuation. But no action was taken and the death toll was very heavy.

The Limitations of Present System: At present, no seismological observatory is authorized to issue any public warning about the likely occurrence of a big earthquake. Usually the warning is issued by Administration. Sometime issue of warning could cause further problem and complications. In the case of Hurricane Katrina in USA, an evacuation warning was issued. Most of the people started with the necessary food, clothing and equipment and wanted to evacuate. But this has caused heavy traffic jam. The expected evacuation during the estimated time could not be

achieved. The result was big chaos. In the case of Wenchuan (Sichuan) earthquake of magnitude 8.0 on 12 May 2008, in China the situation was somewhat different. One scientist had informed about a possible earthquake of large magnitude about twenty days in advance. About ten scientists had informed about the possible earthquake with details about location, magnitude and time about two to three days in advance. But these observations could not get proper priority and the occurrence of an earthquake took a death toll of about eighty thousand lives.

The Odd Administration Situation: If the problem were considered from administration point of view, it would help in understanding the difficulties. There could be two pictures. If the Administration announces likely prediction and the earthquake do not occur and if the Administration does not announce any earthquake prediction and a destructive earthquake occurs. Under both the situations, the Government will have to face heavy criticism. Bapat (2008) has discussed the Himalayan seismic disaster management and odds being faced by scientists and disaster managers while handling the pre-seismic and post-seismic situations. Considering the present development in earthquake prediction, it would be better if Government does not predict any earthquake. Let there be extensive public education about earthquake and creation of seismic awareness. The public education would be so powerful that people would draw their own inferences. When it is seen that a number of reliable seismic precursors are extensively exhibited over a large area, then the Administration should prepare itself to face the situation and should avoid commenting on the public inferences. During some recent destructive earthquakes (magnitude > 7.5) a number of reliable seismic precursors have been seen. It is proposed to discuss these precursors and the respective roles of public, scientists and Administration during pre-seismic and co-seismic periods.

Reliable Seismic Precursors: The seismic precursors could be divided in four categories namely (a) Long Term precursors, (one to five years) (b) Intermediate term precursors (one to three months) (c) Short term precursors (less than one week) and (d) very short term precursors (a few hours before the quake). It is proposed to discuss the last two types of precursors.

Seismo-Electromagnetic Precursors. Prior to the occurrence of a large magnitude earthquake (M > 6.5), the movement of rocks on either sides of rock generates huge heat. This thermal rise is more pronounced for earthquake on normal or thrust type of faults. It may not be that much effective in the case of strike slip faults. The additional heat increases the temperature of the underground rock. The rise in temperature adversely affects the geomagnetic field. The geomagnetic field reduces. This change adversely affects the propagation, transmission, and reception of electromagnetic waves. This is manifested in radio, television telephone and cell phone reception. Bapat (2006), Gershenzon, N. and G. Bambakidis (2001). have reported this in details. Yen (2004) has discussed about changes in geomagnetic field as seismic precursor. In the case of radio reception, it is observed that the reception of radio signal in the potential epicentral area, about three to five days before the earthquake changes. If the radio station were transmitting signal at 2000 kHz, then the same signal would be received in the potential epicentral area at higher frequencies such as 2100, 2200, ….2500 kHz. This is explained by the following equation. The reception of radio signal is governed by the following equation.

(Reception freq) $f = 1/2\pi \sqrt{(LC)}$ ……(1)

Where f is the transmitted frequency, 2 and π are constants, L is inductance and C is the capacitor of the reception system, C may vary from instrument to instrument. But for an instrument it will be constant. The only term, which could affect is inductance L. This is in denominator and in square root sign. As such, a small change in the value of L changes the reception frequency by large value. Equation (1) explains the phenomenon of Seismo-Electro-Magnetic Effect. If this explanation is understood then the physics of earthquake movement of two sections of rock along a geological or tectonic fault and the rise in sub-surface temperature is clearly explained. Enhanced frequency reception was seen for the first time prior to the Tashkent Earthquake of 1966. Subsequently it has been observed at several locations.

There have been reports about rise in reception frequencies prior to earthquakes in India, Turkey, Iran, Japan, USA, Russia, Indonesia, and Pakistan etc.

It must be noted that the transmitted frequency does not change but it is the apparent reception in the potential epicentral area, which shows a change. The changes in reception of radio frequency usually are seen about two to four days before the earthquake.

Reception on Television: About 15 to 20 hours before the occurrence of a medium to large earthquake, there are audio, visual and spectral disturbances on the television in the epicentral area.

Functioning of telephones and Cell phones: About 30 to 50 hours before the occurrence of an earthquake the reception on the telephone is highly disturbed. About 25 to 30 minutes before the occurrence of earthquake, the cell phones start malfunctioning or non-functioning.

How to use the Seismo-Electromagnetic Precursors? If some persons observe the seismo-electromagnetic effect then they should contact other people within about 20 to 40 km radius

distance. If at other locations, similar effects were seen then it would be reasonable to expect earthquake occurrence. The sequence of malfunctioning of instruments is radio first then television and cell phones. When cell phones are non-functioning it is possible that the earthquake is about 30 to 45 minutes away. There are some research laboratories about electromagnetic wave propagation. These laboratories should check the variations in the reception frequencies of various instruments.

Abnormal Animal Seismic Precursor: This has been widely reported and examined. It has been observed that in the case of medium to large magnitude earthquake (M > 6.5) the abnormal animal behavior is observed up to a distance of about 200 km from the potential epicenter. This type of precursor could be minutely observed in zoo, dairies, cowsheds, poultry, Snake Park etc.

The reports from Andaman Island are useful not only for earthquake but also for Tsunami. In the Andaman & Nicobar Island region there is one Island known as Hut Bay. On 25th December 2004, a number of people wanted to have a party on a 100 m long jetty. People gathered on the jetty by afternoon and were busy in preparation of the celebrations. At about 1500 hrs on 25th December 2004, one snake appeared on the jetty. After another thirty minutes, five to six snakes appeared on the jetty. By about 1700 hrs evening the entire jetty was full of snakes, toads, crabs, some types of fishes and other marine animals. The party organizers left the material and ran away from the jetty. One more interesting observation was also found. Normally ants travel in a straight line. A few days before the earthquake, ants were found in a circular cluster jumping over one another. Within twelve hours of the animal crowding the jetty, the earthquake and tsunami occurred. The Hut Bay Island is located at a distance of about seven hundred kilometers from the Sumatran earthquake of 26 December 2004. This is new finding for tsunami. This is usually seen about eight to fifteen hours before earthquake. In case such observations are seen then it should be informed to the administration.

Human Medical Precursor: It has also been observed that about ten to fifteen hours before the earthquake, a number of sensitive persons suffer pains or some physical disorder. Further these are without any apparent reason or provocation. The most noticeable part is rise in number of deliveries about one to two days in advance. Bapat (2006) has reported cases from two Indian earthquakes. It was found that the number of Out Patients Department (who come for treatment and are not admitted in hospital and are known by acronym OPD). The data presented by him are given in Table1 below.

No. of Deliveries	Latur	Andaman
Average / day	3 to 4	1 to 2
3 days before EQ	7	5
2 days before EQ	12	9
1 day before EQ	16	10
On EQ Day	21	10

Table 1. Number of deliveries at Latur and Andaman Hospital

Population at Latur is large while at Andaman it is less. It could be seen that the number of deliveries has increased by 5 to 7 times one day before and on the day of earthquake. Similar rise was also found in the case of Out Patient Department. The Latur earthquake of magnitude 6.25 occurred in Central India on 29th September 1993. The Andaman Earthquake 0f magnitude 9.3 is the same as the Sumatran Earthquake of 26 December 2004.

The exact scientific reason behind abnormal animal and human behavior is yet to be understood properly. But the likely reason could be the charged atmosphere. Before the occurrence of an earthquake, the background natural radioactivity increases. This increases the number of charged particles in the atmosphere. This increase is very high; few order more as compared to the normal amount of charged particles in the atmosphere.

How to use medical data as seismic precursor?
When the area is seismically prone on short or very short-term precursors, various hospitals, doctors and para-medical staff, chemists should watch the situation and report the matter to the Administration.

Aviation Effects: When an aircraft is flying over a potential epicentral zone, there could be some effect of reduction of geomagnetic field on aviation. Prior to the occurrence of the Sumatran Earthquake of 26 December 2004, it was seen that the commercial planes flying from Asia to Australia, over Indonesia, had noticed that the auto-pilot system of the plane was getting disengaged while passing over the seismically active areas in Indonesia. Military planes also experienced similar change. Though the effects on propagation of civil aircrafts are not fatal, but this is also a good indicator of one of the earthquake precursors. At present, data from Sumatran earthquake are available and it needs to be verified in few more earthquakes so that it could be used as powerful tool

Atmospheric Seismic Precursors: It has been reported that there are some remarkable changes in the atmosphere. Upper air pressure and temperatures undergo changes. About ten to thirty minutes before the occurrence of Wenchuan (Sichuan)

earthquake in China on 12 May 2008 unusual light was in the atmosphere. Similar light was also visible prior to the Peru earthquake of magnitude 8.0 on 15 August 2006. At present Chinese scientists are studying this phenomenon. Some person calls it 'earthquake light'. The earthquake light has been discussed by Tsukuda (1992), Yoshida (1994). In addition, halo, mostly of circular or elliptical shapes have been observed and reported by number researchers in Japan and China. Fig. 1 and Fig.2 show the actual photo of the earthquake light seen about 20 minutes before the occurrence of the Wenchuan (Sichuan) earthquake of magnitude 8.0 on 12 May 2008.

The Chinese scientists have claimed that such lights (Fig. 1 and Fig 2) were seen about ten to thirty minutes before the occurrence of earthquake.

Fig. 1 Earthquake Light as seen before the Wenchuan (Sichuan) earthquake of magnitude 8.0 in China on 12 May 2009

CONCLUDING REMARKS

(1) It could thus be summarized that in absence of having a foolproof method of earthquake prediction, it is not advisable that the Government or the Administration should try to predict the likely occurrence of a destructive earthquake. (2) If people were educated about reliable seismic precursors, it would help to create a sense of seismic awareness amongst common people. In case all the above mentioned reliable seismic precursors namely (a) seismo-electromagnetic effect (b) Abnormal Animal Behavior (c) Rise in medical ailments and deliveries (d) Earthquake Light are seen the administration should take a note of these happenings and efforts should be made to co-relate this to the possible occurrence of a large magnitude earthquake. As the data about aviation precursors are limited, this would be discussed in future after collection of additional data.

At present there are a few selected locations where occurrence of a large magnitude earthquake in near future has been predicted. These are (a) NW Himalayan Region in India (b) San Francisco, California, USA and (c) Istanbul in Turkey. If the local administration believes in some work during pre-seismic research work and is aiming at seismic safety of the population, they may include the line of thinking

Fig. 2 Earthquake Light as seen before the Wenchuan (Sichuan) earthquake of magnitude 8.0 in China on 12 May 2009

discussed in this paper. It is also clarified that this line of thinking in this paper has partial scientific basis. Some of the precursory parameters are difficult to be explained within the existing scientific framework. But the precursors discussed have been found to be highly reliable. Till a suitable mechanism to warn the people about imminent earthquake is found scientifically, this approach could be used because seismic safety of population during any seismic contingency has to be given top priority. The author is aware of the limitations of the method.

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