

tices of which are: (i) space availability in a publication, (ii) the level of scientific accuracy, and (iii) comprehensibility of readers⁴.

Reading and research, editing and execution, success and failure, exhilaration and depression, clarity and confusion characterize both scientists and journalists. Dedicated people in both fields strive for accuracy and usually an unselfish motive to help society either through their discoveries or discussions. Under-

standing and collaboration between scientists and science writers would enable effective and accurate communication of essential scientific discoveries.

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Riddle and ridicule of earthquake prediction

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The recent Sikkim earthquake of magnitude 6.8 on 18 September 2011 has caused severe damage in the state. During the last two decades or so there have been a number of destructive earthquakes such as Uttarkashi¹, Latur^{2,3}, Bhuj⁴ Sumatra and Kashmir⁵. Unfortunately, the post-seismic disaster management scenario of successive earthquakes has been 'repeat performance' of the previous events.

After the occurrence of any destructive earthquake, the most favourite and frequently asked question is as follows: 'Is it possible to predict earthquakes?' The answer to this question is highly complex, with real and imaginary solutions. People living in seismically active regions would like to know about earthquake prediction. But most of them feel that earthquakes occur with little notice. However, this misconception needs to be removed. It is the duty of researchers to educate the common man about the seismic precursory indicators.

As the subject of earthquake prediction has not reached any perfection, it is not possible to accurately predict an earthquake with related parameters. It is a fact that the administration is keen to save human lives. But they need some scientific input from researchers. Unfortunately, most of the disaster management activities have been planned for the post-seismic period. Majority of the disaster managers, engineers and some scientists are of the opinion that earthquakes cannot be predicted. As a result, the disaster management scenario has become highly complex with actions and

solutions which are useful only during the post-seismic situation. The past experiences at Uttarkashi (1991), Latur (1993), Bhuj (2001), Andaman (2004) and Kashmir (2005) give almost similar pictures. Usually seismic shaking of moderate to large earthquakes lasts for about 35–45 s. If we divide the seismic shaking in three parts each of about 12–15 s, then during the first part, the disaster managers are highly excited to watch the terrain shaking. In the second part, they are awed by collapse of the structures. In the third part they are horrified to see people dying. After this the disaster managers rush to the site with stretchers, medicine, rescue equipment, etc. Unfortunately, help comes too late, as a large number of people would have already died. There is apparently no activity during the pre-seismic and co-seismic periods. Further, there are no funds or limited funding is available for earthquake prediction research.

The subject of earthquake prediction has made good advances since 1990. Pioneering efforts have been made by Chinese researchers^{6–8}. Despite this, it has not been possible to accurately predict earthquakes with all related parameters of time, space and magnitude. A number of researchers have been using conventional parameters as precursors. The conventional precursory parameters such as geological, geophysical, magnetic, physical and chemical have not been that much useful to accurately predict earthquakes^{9–12}. During the recent decade, utilizing scientific data as obtained from satellites has also been found to

be useful^{13–15}. These are outgoing long wave radiation (OLR) and total electron content (TEC) in the ionosphere.

However, Freund¹⁶ has observed that earthquake prediction would be possible by non-geologic, non-seismic and non-geodetic methods. He stresses the need to monitor short-duration seismic precursors such as changes in the atmosphere, ionosphere, etc. The Chinese researchers have been claiming accurate prediction of earthquakes in the post-seismic analysis. However, they have been able to correctly predict only one earthquake.

It is a fact that the age-old precursor of abnormal animal behaviour had been reliable. Since the Spitak (Armenia) earthquake of December 1988, abnormal human behaviour has been found to be useful¹⁷. Just like animals get disturbed about 10–12 h before an earthquake, human beings also get disturbed. Human health gets suddenly disturbed. About a day before the earthquake, an abrupt rise is seen in psychosomatic disorders and diseases such as blood pressure, heart trouble, vomiting, headache, migraine, uneasiness, etc. The number of deliveries and out-patient department (OPD) patients rises by 5–7 times before an earthquake. This observation from Spitak was verified during post-seismic studies at Latur. On an average there were about 3–4 deliveries at the Latur Civil Hospital. But on the penultimate and ultimate days of the earthquake, the figures were 17 and 21. Most seismologists routinely measure the conventional parameters. But it needs to be noted that these

parameters could be measured at any time. The abnormal animal and human parameters are of short duration and appear only few hours before the occurrence of an earthquake. As such, these are more reliable. The abnormal animal and human behaviour is due to sharp rise in the number of charged particles in the atmosphere of the potential epicentral area.

Despite all these advances, it has to be admitted that at present, it is not possible to predict all the earthquake parameters in time, space and magnitude. However, the pre-seismic situation could be 'sensed' by certain parameters. If common people are educated about the reliable seismic precursors, then they would draw their own inferences about the occurrence of an imminent earthquake. Such an effort has been made by the Assam State Disaster Management Authority (ASDMA). In February 2011, ASDMA has released a pamphlet about reliable seismic precursors for the common man¹⁷. The pamphlet is to be distributed up to Gram Panchayat level in each village.

Some of the rules and regulations in the Disaster Management Act of the States and Government of India do not allow people to predict earthquakes. Further, the rules say that such a person is liable to be prosecuted. In November 2000, an astrologer from Ahmedabad had predicted that around 25 January 2001, Gujarat would be shaken by a destructive earthquake. This was not taken seriously till mid-January 2001. But around 23 January people started to panic and reached its peak on 24 January 2001. The astrologer was arrested and placed in police custody for spreading rumours. The earthquake occurred on 26 January 2001 and he was immediately released.

On the other hand, the example from Italy is horrifying¹⁸. On 6 April 2009, a magnitude 6.3 earthquake occurred at L'Aquila in Italy, killing 308 persons, leaving 1600 injured and more than 65,000 homeless. Prior to this event, a magnitude 4.0 earthquake occurred on 30 March 2009 in the region and there was public apprehension and fear psychosis due to some small-magnitude earthquakes during the preceding few days. The official Italian agency for disaster management visited the site on 31 March

2009 and it was officially announced that there is no danger of any earthquake and people need not worry. But the deadly earthquake occurred within six days with heavy loss. The affected people requested the local lawyer to file a case of manslaughter against the expert committee. The L'Aquila Chief Prosecutor, told the Italian press on 3 June 2010 that after examining the rules, regulations and acts, he was left with no choice but to proceed with an investigation. Also, his office had gathered enough information to indict the individuals named for manslaughter and a case has been filed and admitted. This prosecution has been objected to and protested by the international community of researchers. It needs to be noted that Italy has a historical track of prosecuting scientists. Galileo the famous astronomer was called to Rome for punitive legal action in 1633 for stating that the sun was at the centre of the planetary system. It is hoped that there will not be any torturing of Italian scientists in the present case.

The earthquake prediction situation is paradoxical and skewed. Accusation, charging, legal actions, threats and any egoistic administrative action would worsen the situation, and no researcher would come forward to predict earthquakes fearing legal action. This would reduce or perhaps stop earthquake prediction research. The research funding agencies may not grant any funds for earthquake research. This could increase the death toll in future earthquakes. Various research institutions and funding agencies should try to encourage research in earthquake prediction. At present, some sites have been identified as most vulnerable to earthquake disaster in the near future. These are the NW Himalayan region, Assam and NE India, San Francisco (California) and Istanbul (Turkey). The administration and researchers in these countries are examining the earthquake threat in the areas. A number of researchers are regularly monitoring various precursory seismic parameters. But the achievable aim is still dodging the scientists. All avenues should be tried without any bias for or against the parameter.

Whether to predict an earthquake or not is the main question. The best way

would be to bring together earthquake researchers, legal luminaries, administrators, disaster managers, etc. and try to find out a viable solution which would help save human lives. The solution would be such that it would save people or help save people during an earthquake, and no researcher would be prosecuted or penalized. Remember, earthquake prediction can be powerfully wrong or powerfully right.

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