Disaster management plans in view of recent earthquakes

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The present decade could be called as disaster management decade. There have been a number of large mega geo events such as Sumatran earthquake of magnitude 9.3 in December 2004, and destructive earthquakes in India (Bhuj earthquake of magnitude 7.8 on 26 January 2001), Pakistan (Kashmir earthquake of magnitude 7.9 on 8 October 2005) and China (Sichuan earthquake of magnitude 8.0 on 12 May 2008). About half a million lives have been lost in these seismic disasters. As each earthquake has a different signature, each earthquake teaches something new. It is the duty of earthquake researchers and disaster managers that the lessons learnt from these seismic contingencies should be scientifically studied; analysed and significant inferences and conclusions should be taken to the common man with a view of increasing the seismic safety of the society in general and human lives in particular. It is a fact that despite several laudable researches in the fields of earthquake and disaster management, it has not been possible to save a single life during any earthquake (except one in China). The hind-casting exercises of above earthquakes have indicated a number of highly reliable seismic precursors. The situation appears to be moving in skew directions. On one hand scientists have been coming forward with sufficient degree of confidence about reliable seismic precursors and on the other hand, the disaster management experts vehemently say that earthquakes cannot be predicted. The result is more concentration of equipments, instruments, and remedial measures during the post-seismic period by the disaster management experts. Unfortunately, it could be observed that the present disaster management plans almost do the work of clearing of debris and corpses during the post-seismic periods. This has to be changed positively and immediately. It is essential that new policies have to be formulated. These have to be based on the lessons learnt from various earthquakes.

The NW Himalayan region comprising of conglomerate of Himachal and Uttarakhand has been identified as the most vulnerable seismic region with large magnitude ($M > 7.5$) earthquake. The probability of occurrence of such an event is of the order of about 0.986 (refs 1 and 2). In case such an earthquake occurs, the damage would be almost astronomical within the epicentral area. Further, tall structures of more than 17 m height, in the National Capital Region of Delhi could suffer heavy damage.

The Sumatran earthquake was perhaps the most powerful earthquake. Some post-seismic hind-casting exercises have led to new findings. The sea surface temperature (SST) of the area above the epicentral region was higher by 3.0–5.0°C for about a week or so before the occurrence of earthquake. The SST and also the land surface temperatures are available almost on an hourly basis from various satellite pictures. This has shown that the temperatures of the potential epicentral region rise. One day before the occurrence of the Kashmir earthquake of 8 October 2005, the temperatures in the epicentral area were about 8.0–10.0°C above the normal temperatures. Keeping this in view, watch could be kept on different locations in NW Himalayan region. It has been observed from the daily weather reports for the period 1 January 2009 till the time of writing (March 2010) of India Meteorological Department (IMD) that the maximum and minimum temperatures of Shimla, Srinagar and Dehradun have been above normal by 2.0–4.0°C on lower side and as high as 8.0–12.0°C on higher side.

The Bhuj earthquake of 26 January 2001 in India and the Kashmir earthquake of 8 October 2005 have shown the likely damaging effect of Rayleigh waves from large magnitude earthquake. Bapat[3] has discussed this effect observed during Gujarat earthquake. The Rayleigh waves which are long-period waves (period 12–18 s) from a large earthquake of magnitude more than 7.5 have a special property. These waves adversely affect tall structures, height more than 17 m, situated beyond a distance of 150 km and less than 550 km from the epicentre. Such a phenomenon was observed for the first time during the Mexican earthquake of September 1985. Mexico city is located at a distance of about 550 km from the magnitude 8.0 earthquake. Only tall structures ($h > 17$ m) have suffered heavy damage. Structures with one, two or three floors did not suffer any damage or the damage was almost minimal. During the Bhuj (Gujarat) earthquake, tall buildings in Ahmedabad city located at a distance of about 320 km from the epicentre have suffered heavy damage. During the Kashmir (Pakistan) earthquake, a 10-storey building in Islamabad had totally collapsed. A recent example from Guwahati is quite interesting. Bhutan had experienced a magnitude 6.25 earthquake on 21 September 2009, with epicentre at 27.3°N and 91.5°E. A tall building in Guwahati (located at a distance of about 150 km from the epicentre) has tilted by about 4°–5°. Had the magnitude of the earthquake been 7.0 or more the structure could have suffered heavily. Keeping in view these field observations, it would be necessary to draw vulnerability map of tall structures situated within 550 km from the probable epicentre in NW Himalayas for locations like Delhi, Noida, Gurgaon, Ghaziabad, Jaipur, Agra, etc. Incidentally, the Bureau of Indian Standards Seismic Code was revised after the Bhuj earthquake. But it does not have any revision to account for the effect of Rayleigh waves on tall structures located within the vulnerable distance from the epicentre.

It was widely reported that prior to the Wenchuan (Sichuan) earthquake of magnitude 8.0 on 12 May 2008, in China a large number of toads were leaving ponds and roaming on nearby road. The abnormal animal behaviour (which cannot be explained within the presently established framework of science) should be accepted as a reliable seismic precursor. Whether a suitable explanation is available or not till it works, one should accept this precursor and use it to save lives of people. This has also been mentioned in the ancient Indian literature *Brihatsamhita* of Varahamihira. Recent research in US has shown that the number of charged particles in atmosphere increases several times than the normal[4]. The excessive charged particles could be a likely reason for the abnormal animal behaviour. It is also reported that in

addition to abnormal animal behaviour, there are some abnormal human behaviours. Bapat[5] has reported that prior to the occurrence of Latur, Bhuj and Andaman earthquakes, the rate of deliveries was higher by 5–7 times than the daily average rate. Hospitals and medical doctors should be told about this precursor.

The Haiti earthquake has given two most significant observations. It is well known that prior to the occurrence of moderate to large earthquake the changes in the geomagnetic field adversely affect the propagation and reception of radio waves in the potential epicentral area[5]. This effect is known as 'Seismo-electromagnetic effect'. About a day before the occurrence of Haiti earthquake, the radio communication was heavily obstructed and at times blocked. This observation could be used in India. Various communication departments such as police, army, airports, television channels, mobile telephone companies and All India Radio may be made aware of this effect and any abnormal and unusual difficulty in communication such as difficulty, obstacle and 'black out' may be reported to the disaster management office. Black out means the signal is not received at all.

Another observation from Haiti is about disaster management. At a number of locations in Haiti, houses are located on hill slopes and hill tops. There is only one road connecting various hills and houses are built on either sides of the road. During earthquake the available single road was blocked due to landslide or fall of houses. As a result the medical team, rescue team and earth moving equipment could not reach the required point. This had caused more damage. There are a number of towns such as Shimla, Dharamsala, Nainital, Mussoorie, Shillong and Aizawal, having similar situation in the hilly region of the country. In case there is only one road connecting most of the localities, then suitable provision for alternate route or by pass route should be made to avoid blockade of roads. The capital of Mizoram, Aizawl, is a typical example. There is only one road of about 9.0 km length connecting the city.

The Chile earthquake was not preceded by a large number of foreshocks. This is somewhat unusual. There is an interesting story about the foreshock of previous large magnitude earthquake of 1960. The 22 May 1960 Chile earthquake of magnitude 8.7 was preceded by two foreshocks, one of magnitude 7.0 and the other of magnitude 7.5. Everybody thought that magnitude 7.0 is foreshock and the 7.5 earthquake is the final seismic event. But both the earthquakes were foreshocks of the very large magnitude earthquake of magnitude 8.7 on 22 May 1960. These observations are interesting. At present, the matter is under study and some interesting observations would emerge. There was no major foreshock before the Bhuj earthquake. But there were heavy microtremour activities at Jamnagar, Rajkot, etc., about 50 days before the earthquake. In the case of 26 December 2004 Sumatran earthquake of magnitude 9.3, there were five earthquakes of magnitude 5.6, 5.1, 5.0, 5.3 and 5.9 within about 14 hours on 29 July 2004. This was a series of foreshocks for the main seismic event. The mechanism of foreshock(s) needs to be studied in detail for various locations. This definitely helps in understanding the stress building activity.

Everybody should learn and educate himself from the earthquake observations and it would be possible to mitigate the earthquake disaster. The ultimate aim of disaster management should be saving human lives. It is hoped that the lessons from various earthquakes would be useful in dealing with the pre-seismic and post-seismic situations in NW Himalayan and other regions. Suitable modifications in the disaster management plans may be incorporated and used. If suitable actions are undertaken during the pre-seismic period and a watch is kept on several reliable seismic precursors, it would be possible to mitigate the earthquake disaster.

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