direction and stability to an equitable sharing and beneficial use of a vital resource.

Three years is a short time. One would hope that the momentum on a National Water Policy will be maintained by taking the indispensable first step of defining and setting up a process that will facilitate a harmonious coming together of science and policy. The daunting task will test the skills, talents and creativity of the best Indian minds from the humanities to the sciences. In a technological world that is in transition from a mindset of exploiting nature to one of adaptation, India has an opportunity to provide world leadership in water and natural resources management.

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Socio-legal aspects of earthquake prediction

The subject of earthquake prediction has been undergoing several transient stages. Initially it was almost an outcast subject, then it became a non-scientific subject. At this stage statistical probabilistic values of earthquake occurrences were considered seriously. But these were for medium to long-range forecast on time-scale. At present it is almost on the verge of partial acceptance as a branch of earth sciences. It is hoped that within the next few years it would attain the status of a fully acceptable branch of geosciences. The most vital point is all these efforts of prediction is invariably aiming at saving human lives during destructive earthquakes. At present, there is no official or administrative mechanism to issue any alert or warning signal about the imminent earthquake. This could be one of the reasons for the high death toll during the recent Bhuj (2001), Andaman (2004) and Kashmir (2005) earthquakes.

With this background it would interesting to examine the scenario in Italy. On 6 April 2009 a magnitude 6.3 earthquake occurred at L'Aquila, Italy, killing 308 persons, leaving 1600 injured and more than 65,000 homeless[1]. Prior to this, a magnitude 4.0 earthquake had occurred on 30 March 2009 in the region and there was public apprehension. 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 further earthquakes. But the deadly earthquake occurred within six days with heavy loss. The affected people requested a local lawyer to file a case of manslaughter against the expert committee. L'Aquila Chief Prosecutor, Alfredo Rossini, 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 and that his office had now gathered enough information to indict the individuals named for manslaughter and a case has been filed.

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.

In USA, the possible occurrence of an earthquake, popularly known as the Parkfield earthquake, was announced in 1984. But it did not occur for more than two decades. After the failure of the Parkfield earthquake prediction, the Government reduced grants for earthquake prediction research.

There are similar cases in India about earthquake prediction. Before the occurrence of M 6.3 Latur earthquake on 29 September 1993, it was announced by India Meteorological Department (official agency to study earthquakes), that there will not be any earthquake and people need not have any apprehensions. But the earthquake occurred within a week and resulted in a death toll of about 10,000 lives.

There is the case of a Chennai geologist who had predicted that Dibrugarh town in Assam would experience a large-magnitude earthquake (7–8 on the Richter scale) on 8 September 2006 at 0821 h (IST). The earthquake did not occur, and the people of Dibrugarh as well as the administration were relieved.

It needs to be noted that the occurrence of the Bhuj (2001) earthquake was accurately predicted astrologically by Ambalal Patel. He had written in November 2000 in a Gujarati newspaper that Gujarat would experience a destructive earthquake during 24–26 January 2001. He was arrested two days before the earthquake for creating panic and fear psychosis, but was released immediately after the earthquake.

With the above background it would be interesting to examine the present seismic scenario in the country. The Northwest Himalayan region consisting of Himachal Pradesh and Uttarakhand is heading for a large-magnitude earthquake according to several studies[2–5]. NE India has been identified as one of the 10 most vulnerable seismic areas in the world. There are various legal provisions in the National Disaster Management Authority (NDMA) and various State Disaster Management Acts about prediction and false prediction of earthquakes.

The present Indian seismic scenario could be summarized as follows.

(a) Scientifically accepted observations indicate that large-magnitude earthquakes are expected in NW and NE Himalayan regions.

(b) There is no provision of the issue of any alert or warning system about an imminent large-magnitude earthquake in the NDMA Act.

(c) A number of scientists are doing research in earthquake prediction and the Ministry of Earth Sciences has established a multiparameter laboratory in Uttarakhand with a view to predicting earthquakes.

(d) Traditional reliable seismic precursors such as abnormal animal and human behaviours are not accepted, because the

presently established scientific framework is not able to explain it[6]. But this has been found to be a reliable seismic precursor prior to all destructive earthquakes in all countries.

(e) People and NGOs are becoming active and use of the Right to Information (RTI) Act could lead to unforeseen legal action after any deadly seismic contingency, against scientists, disaster managers, administration and the government.

(f) Incidentally, the two sentences, '. . . An earthquake of magnitude M would occur at place X on such and such date', and '. . . Earthquake of magnitude M will not occur at place X on such and such date', convey opposite meaning. But both are predictions! Paradoxically, the former statement is mostly ridiculed, whereas the latter is accepted.

In the interest of seismic safety and saving lives, it is essential that a suitable viable solution to the problem should be found out at the earliest. The government could formulate suitable guidelines for this problem, which is progressing from a simple to a highly complex state. It is possible, under the present conditions, that even after confirming the possibility of occurrence of a destructive earthquake based on purely scientific observations, due to fear, it would not be announced by the scientists and administrators. The Ministry of Earth Sciences, Department of Science and Technology, concerned scientists, research institutions and disaster management experts should deliberate upon the issue and come out with a viable solution which could protect scientific freedom, ease disaster management, make provisions for avoidance of any legal action arising out of prediction (or lack of it) of earthquakes; the main objective should be to save the lives of people. This would create faith in the administration and research. Otherwise people would be required to undergo the agony of 'legal aftershock' after a destructive earthquake.

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Scenario of science Ph Ds produced in India by 12th five-year plan

The economic growth of any country is related to knowledge-based innovations which are directly associated with human capital. Doctorates in science and technology (S&T) are the most significant S&T indicators that promote innovations.

During 2005–06, only 52% of all senior secondary-level students opted for graduate-level education. The postgraduate enrolment was just 13% of the graduates and the number of students enroled for Ph Ds in all subjects during the corresponding period was just 4% of the postgraduates[1]. According to the India Science Report 2005, 22.3% of 39.2 million graduates, 19.4% of 9.3 million postgraduates and one-third of 0.3 million doctorates during 2004 were from the science stream. During 2001, India produced 4616 Ph Ds in science, which increased to 5539 in 2003. According to the Ernst & Young EDGE-2008 report on 'Globalizing Higher Education in India', there is a 58% shortfall of engineers and 80% shortfall of doctorate scientists in the country[2].

The existing trends (Table 1) and the estimated number of Ph Ds produced during the 11th and 12th five-year plans (Figure 1) clearly indicate that the number of Ph Ds produced is small compared to the number of students enroled for postgraduate studies (M Sc).

Efforts are being made to motivate more students with M Sc to register for Ph D and take up science as a career. The Government has recently approved a CSIR proposal on 'increase in number of Junior Research Fellowships (JRF) through CSIR–UGC National Eligibility Test (NET)' during the 11th five-year plan (2007–12), by at least twofold over the number (~6000) of fellowships (JRFs) awarded during the 10th five-year plan period (2002–07). The Rajiv Gandhi National Fellowship (RGNF) scheme funded by the Ministry of Social Justice and Empowerment and the Ministry of Tribal Affairs has been instituted for candidates belonging to the Scheduled Caste (SC) and Scheduled Tribes (ST) to pursue higher studies leading to the award of M Phil and Ph D degrees in science, humanities, social sciences, and engineering and technology. About 1300 fellowships are available for SC, and 600 for ST candidates every year for all subjects. The Department of Science and Technology has instituted the 'Innovation in Science Pursuit for Inspired Research (INSPIRE) Scheme' to attract more students towards science in the country. The basic objective of INSPIRE is to communicate to the youth of the country the excitements of creative pursuit in science, attract talent to the study of science at an early stage and thus build the required critical human resource pool for strengthening and expanding the science and technology system and R&D base.

There are about 1.5 lakhs core researchers in India compared to 8–10 lakhs in China. The number of persons doing research in India is 156 per million of the population in contrast to 334 per million in Brazil, 7000 per million in the Scandivan countries and 4700 per million in the US[3]. Though China was producing less number of Ph Ds than India till 1995, it has now surpassed India in terms of the number of Ph Ds produced in science and engineering. During 2001, China produced 3812 Ph Ds in science, which increased to 5665 in 2003, with a growth rate of 48.6% compared to India's 20% growth during the same