species, is in danger. It would, therefore, be important to analyse management implications of such a scenario in protected as well as unprotected areas.

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An *M* 5.2 earthquake occurs in Koyna region after 4½ years

Koyna, located near the west coast of India, is known to be the most significant site of artificial water reservoir triggered earthquakes. The activity started soon after the filling in of the reservoir in 1961 and during the last 44 years, an earthquake of M 6.3, 19 earthquakes of $M \geq 5$, about 170 $M \geq 4$ earthquakes, and several thousand smaller earthquakes have occurred. As far as $M \geq 5$ earthquakes are concerned, the site had been quiet for some time, the last earthquake of $M \geq 5$ having occurred on 5 September 2000.

In a detailed investigation, Gupta *et al.*[1] speculated as to how long triggered earthquakes would continue at Koyna. They concluded that a maximum credible earthquake for the region is M 6.8. So far, about one-half of the energy of an M 6.8 earthquake has been released. Considering that the region got activated soon after filling of the Koyna dam in 1961, the activity should continue for another 3–4 decades. However, there was no large enough intact fault segment left to cause an earthquake of M 6 like the one on 10 December 1967. At the same time, smaller earthquakes will continue to occur, governed by Kaiser effect, rate of loading, and duration of retention of high water levels. In another study, Gupta[2] pointed out that most of the earthquakes of magnitude 4 or larger have occurred in Koyna region following the high rate of loading soon after the monsoon months – September to December. Another peak of activity occurred during the unloading stage of the reservoir during the months of February–March.

The current seismic activity of M 5.2 on 14 March, and two earthquakes of $M > 4$ on 15 and 26 March occurred during the unloading period (Figure 1). The epicentral location of earthquakes of $M > 5$ in the Koyna–Warna region is shown in Figure 2. Figure 3 *a* shows the distribution of earthquakes of $M \geq 3$ since January 2003, and water levels in the reservoir. It may be noted in Figure 3 *a* that the enhanced activity during the month of March 2003 was associated with unloading of reservoir, and the same is the case with the enhanced activity in the month of March 2005 where there are several earthquakes of $M \geq 3$, two earthquakes of $M \geq 4$, and one earthquake of $M \geq 5$. It is in line with the earlier picture where it was noted that maximum number of earthquakes of $M \geq 4$ occurred in the month of September due to rapid loading of the reservoir, and another peak occurred in the month of February following unloading of the reservoir (Figure 3 *b* after Gupta[2]).

Another interesting thing to note is that most earthquakes exceeding M 5, which occur in the unloading phase, are close to the Warna reservoir. For example, nos: 17 and 18 in Figure 2 and the March 2005

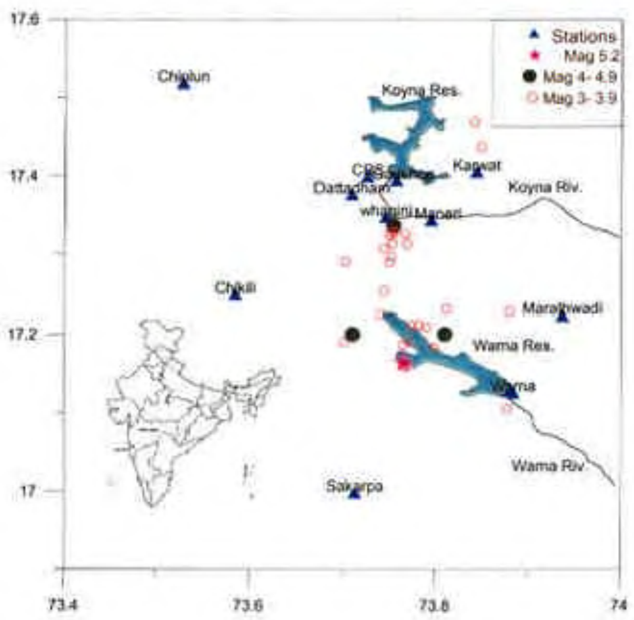

Figure 1. Seismic activity in the vicinity of Koyna region for the period January 2003 till 31 March 2005. Only earthquakes of magnitude 3 are included. Note that the recent M 5.2 earthquake on 14 March 2005 occurred close to Warna region.

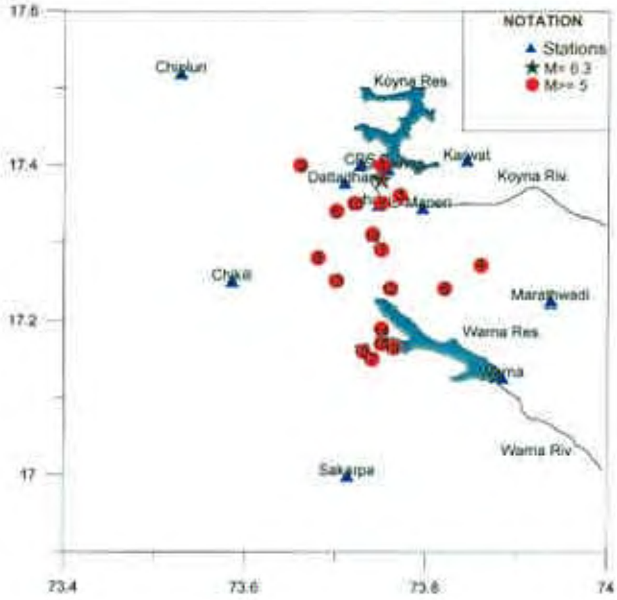

Figure 2. Earthquakes of magnitude 5 and larger which occurred in Koyna region. It may be noted that the current earthquake, and 16, 17, 18 occurred close to Warna reservoir, which are related with unloading of the reservoir.

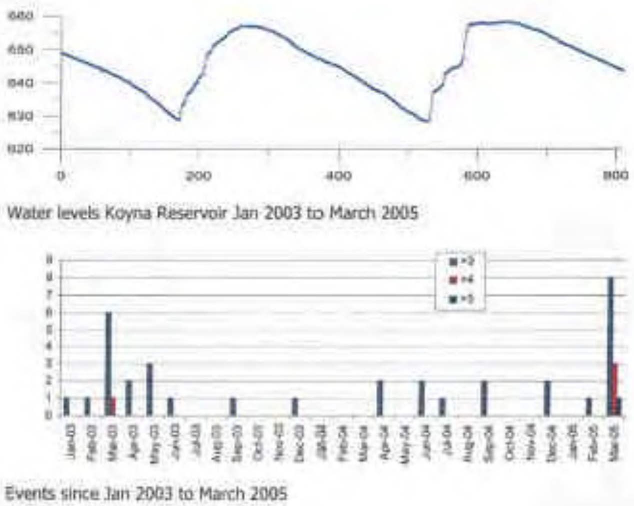

Figure 3 ***a*****.** Water/reservoir levels in Shivaji Sagar Lake created for Koyna region from January 2003 to March 2005, and earthquakes of magnitude 3 and above. Note that the enhanced activity during March/April 2003, including an M 4 earthquake, was associated with unloading of the reservoir. Similarly, the enhanced activity in March 2005, including one earthquake of $M \geq 5$ and two earthquakes of $M \geq 4$ occurred in the month of March and is also associated with unloading of the reservoir.

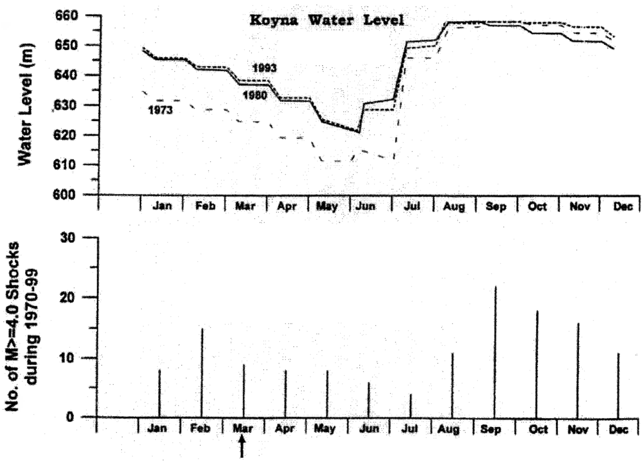

Figure 3 ***b*****.** Water levels in Koyna reservoir for the years 1973, 1980 and 1993, and the monthly number of earthquakes of M 4 and larger for the period 1970 through 1999 (after Gupta[2]). It may be noted that the largest number of $M \geq 4$ earthquakes occurred in the month of September soon after rapid loading of the reservoir. Another peak is seen in the month of February associated with unloading of the reservoir. The seismic activity in March 2005 is associated with unloading of the reservoir.

earthquake of $M \geq 5$. The current seismic activity in the Koyna region is a continuation of the triggered earthquakes, and has nothing to do with the Sumatra earthquake as reported in the news media. The current seismic activity is also related with the unloading of the reservoir.

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