India and it is well managed by the forest department. The entire grove is fenced, which prevents the area from any encroachment or other anthropogenic disturbances. Ecological status of the sacred grove is also good. During our two-year study, we found little grazing, fuel-wood collection or forest fire incidence in the study site. The only activity that we noticed in the study site was the religious tourism. The tourists bring a lot of polythene and plastic goods with them. One can see huge lumps of these goods, which gives a shabby look to the sacred grove and imposes great threat to grove's floral and faunal diversity. There is no waste management in and around the shrine. We feel that to save the floral and faunal diversity of the Shankaracharya sacred grove all the polythene and plastic debris should be removed from the forest floor and it must be declared a 'no polythene zone'. Another problem related with the tourism was various self-made footpaths (shortcuts) adopted by the devotees to reach the temple. The footpaths remove the top soil and also denude roots of the trees, ultimately resulting in their uprooting during rainy season.

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KEWAL KUMAR[1]
R. K. MANHAS[1,*]
RANI MAGOTRA[2]

[1]*Department of Botany, S.P. College, Srinagar 190 001, India*
[2]*Department of Botany, University of Jammu, Jammu 180 001, India*
**e-mail: manhasrk@rediffmail.com*

Whose fault is it?

I read the article by Valdiya[1] with great interest. It was a passionate call from a veteran geologist to younger geoscientists to undertake comprehensive and imaginative studies on the earthquake source zones in the country. While the complexity of the problem should make us humble, it cannot be a reason to remain complacent about addressing the challenges. In a vast country like ours, with such a huge population, we are expected to generate a lot more ideas to tackle the problems that are unique to our country. There cannot be any doubt that one of the most important issues that face our society includes natural disaster management. The primary issues that we need to address here are whether our research priorities address specific issues of the problem and whether or not our scarce resources are being put to optimum use. We have to think about what is more important – sending a man to the Moon now or addressing our water-related problems. We also need to remember that this spike in our GDP may not last forever and someday, like elsewhere, such peaks can plateau out (like human life). Remember the fact that wealth generated is finite and we have to use it judiciously and optimally. As Valdiya points out, natural hazard reduction should be one of our most important priorities for the simple reason that a major earthquake whether in the Himalaya or elsewhere, for instance, will be devastating for the Indian economy, not to speak of the pain, agony and trauma of thousands of victims who would be terrorized by the suddenness of nature's fury.

It is easier to say that wide ranging observations can be brought to bear to formulate conceptual and quantitative earthquake source models. The issue at hand is how to generate them. For instance, it is important that we generate a first approximation inventory of active faults, identified on the basis of seismological, geological and geophysical studies. How do we go about doing that? What is our working definition of an 'active' fault? What are the criteria useful to characterize the 'activeness' of a fault? We know that the morphological features exhibited by drainage systems alone may not be a sufficient criterion to define ongoing fault activity. We need to employ several more techniques to define an active fault, if the structure in question is going through a seismically quiescent period. Importantly, we need to see if the recent deposits and local geomorphology exhibit the traces of faulting or displacement either through near-field observations or remotely through satellites (or still better, by acquiring air-borne Light detection and Ranging Imagery, called LIDAR). Fault kinematics can better be understood if this kind of a basic database is available. Spatial data in various formats and scale come in handy for a geologist making these kinds of first approximations. In this background, Valdiya raises several valid points, with primacy on topographic maps and the lack of their easy availability.

How does a geologist work and publish without the aid of suitably scaled maps? This complaint is not restricted to topographic maps and to the Survey of India, an institution which still wallows in archaic British Indian laws; it is equally valid for satellite-derived spatial data produced and marketed by hi-tech institutions, like ISRO. I am quoting from Pallava Bagla's article on the Indian space agency[2]: 'The biggest headache for companies and nonprofit researchers hoping to use satellite images may be India's 2001 Remote Sensing Data Policy. It gives NRSC a monopoly within India to control access to images with less than 5.8-meter resolution – not just images

from Indian satellites but also those from foreign sources.' It is another matter that even with all these pricing policies the concerned agency is able to recover only 7% of its operational cost[2]. Why aren't these data products made available, free of cost, to researchers? It is remarkably comical that while this restrictive policy is being implemented resolutely, Indians have direct and free access to Google Earth images from their computer terminals! For the geosciences to develop on a fundamental level, I think, the immediate task is to release the shackles on spatial data (at various scales). In fact, the Government should encourage formally free access and global sharing of all Earth science data for research purposes. Such restrictive policies also have a bearing on the inability of the concerned agencies to develop a web-based real-time online archive of seismicity data of the country.

Valdiya[1] also focuses on various parts of the country that require attention from the point of view earthquake hazard assessment. It is very feasible that Peninsular India, a stable continental interior, may contain potential seismogenic structures that are as yet undetected. Recently a colleague showed me some exposures of brittle faulting in lateritic soil. These features surprised me, first as they most likely represent possible geologically recent seismic activity and second, because of their discreet locations. We need to understand more about why and how such regions in continental interiors respond to first and second order stress accumulations. A similar situation exists in the Australian hinterlands where Quaternary fault scarps are enduring curiosities for geoscientists. Away from plate boundaries, such discreet faults sometimes get mysteriously energized momentarily to wreck havoc, as in the case of the 1993 Latur earthquake. What we found later in Latur was that earlier fault movements were imprinted on the rocks there. It is an interesting Earth science problem and the challenge is to use such information in seismic hazard scenarios.

I believe the central Himalaya and Northeast India require close attention and the highest priority in terms of earthquake expectancy and the development of hazard reduction scenarios. My occasional forays into the Himalaya shock me each time with an exponential increase in the squalor and poverty of the region, accompanied by a continually deteriorating environment and encumbered by failing infrastructure, which includes the sorry state of the existing roads and bridges. I am certain that this is not the way to better our society's endurance and improve our staying power to meet high impact disasters like earthquakes. Everywhere in Himalaya you see farm lands shrinking and people frantically busy building, in the most productive land, caring not even in the slightest about any building norms and environmental safeguards. Laurie Baker (who was a resident of Pithoragarh in 1960s) called such buildings as 'horrible rubbish', 'modern monstrosities' and 'imported horror', and he cautioned not to rely on them in an earthquake[3]. Natural springs and channels are clogged with plastics and each time I see women trudge longer distances to fetch water. Basic education and public awareness programmes promoting literacy on these issues should be conducted routinely in these areas. But whose onus is it to ensure this happens? Who is supposed to implement the land zoning and building rules? Many of these problems are directly related to the Indian population density and poverty. What we need is a renewed commitment to family planning policies. My Australian colleague had a shocked look on his face when he saw the teeming population on both sides of the roads in Uttar Pradesh, on our way to the Himalaya, recently. What is our long-term plan to reduce human migration to riskier terrains? How many of the buildings that are constructed in these terrains actually followed earthquake safety regulations? It will be worthwhile to make a census of the building stock in the Himalaya and see how many of them are constructed following some, if any, legal provisions. As a first exercise we could conduct a vulnerability study of buildings and facilities in the earthquake-prone areas and the National Disaster Management Authority (NDMA) is the right agency to lead this exercise.

While emphasizing the importance of conducting high quality research on earthquake generation, we should not forget the importance of the earthquake engineering aspect of the problem – prediction of the effects of earthquakes is equally important. For example, it is important that we give priority to develop basic data and methodologies for the prediction of earthquake-induced ground shaking at local and regional scales. This includes the acquisition and interpretation of basic data necessary to develop regional ground motion predictions. We also have to develop and improve our methods for identifying and mapping areas of potential ground failure. All these information may be put into a suitable GIS format at various scales and any agency for local governance can have it on their desktops. All our decisions on land development or building plans should be based on scientific judgements.

But then, the quality of the decisions made depends also on the quality of the minds making them. Recently, I saw a quote from Edmond Wilson, a largely forgotten American literary critic, in Pankaj Mishra's book, *Temptations of the West*. The quote is from Wilsons' essay on Flaubert's novel *Sentimental education*. It reads like this as: 'Flaubert's novel plants deep in our mind an idea which we never quite get rid of, the suspicion that our middle-class society of manufacturers, businessmen, and bankers, of people who live or deal in investments, so far from being redeemed by its culture, has ended by cheapening and invalidating all the departments of culture, political, scientific, artistic, and religious, as well as corrupting and weakening the ordinary human relations: love, friendship, and loyalty to cause – till the whole civilization seems to dwindle.' This is what I would like to add to the last part of Valdiya's article.

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C. P. RAJENDRAN

Centre for Earth Sciences,
Indian Institute of Science,
Bangalore 560 012, India
e-mail: cprajendran@ceas.iisc.ernet.in