

With structural constraints of traditional impact assessment techniques, biodiversity concerns are often not addressed to a reasonably good extent. EIA and SEA alone are unable to affect the shift in the requisite development path as envisaged in the CBD.

BIA is a new technique that can potentially help EIA and SEA to achieve the three major mandates of the convention on biological diversity.

To conclude, a more complete survey of the existing EIA legislation is needed to determine the extent to which it meets the CBD's mandates. But there is a need for further discussion about the

potential uses of BIA and methodology. To begin the process the following can be taken as recommendations: (i) Establish transparent EIA and SEA methodologies. (ii) Discuss the role of BIA in existing EIA and SEA processes. (iii) Develop BIA methodology (perhaps on a case-by-case basis). (iv) Determine how BIA can alter decisions on EIA. (v) Integrate BIA into the planning process.

Responses to these recommendations will be more than welcome.

1. UNEP 1992, The Convention on Biological Diversity, Nairobi.

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3. Roe, D., Dalal-Clayton, B. and Hughes, R., *A Directory of Impact Assessment Guidelines*, IIED, London, UK, 1995.
4. Bagri, A., McNeely, J. and Vorhies, F., *Biodiversity and Impact Assessment*, International Association of Impact Assessment, Christchurch, New Zealand, April 1998.

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Active tectonics and paleoseismology

A short course on active tectonics and paleoseismology was organized jointly by the Centre for Earth Science Studies, Thiruvananthapuram, and J. N. Centre for Advanced Scientific Research, Bangalore, at Bangalore, during 14–19 September 1998. C. P. Rajendran and K. S. Valdiya were co-ordinators of the course which was sponsored by the Department of Science and Technology (DST), Government of India. Fifteen participants, selected out of 89 applicants, represented universities and research institutes all over the country. Participants from different parts of the country including Manipur, Assam and Andaman and Nicobar islands formed a cross section of researchers from different geographic and tectonic provinces. The faculty for the course was selected to ensure that a cross-disciplinary, integrated approach to addressing active tectonics and paleoseismology problems comes through and there is a perfect blend of classical and contemporary ideas. The efforts of the organizers and the DST resulted in a remarkable course which drew universal accolades and all of them considered it to be one of the best courses they had ever attended.

The curtain raiser was a welcome address by M. Baba (Director in-Charge, CESS, Thiruvananthapuram) who pointed out that the process for participant selection focused on the current and future research potential of

the participants and the need to ensure maximum possible diversity in geographic area and earth science disciplines amongst participants. This was followed by an introduction to paleoseismology by C. P. Rajendran (CESS) who along with Kusala Rajendran (CESS) gave a series of excellent lectures on the core concepts in paleoseismology, active tectonics and seismology. Their efforts were complemented by experts in fields related to active tectonics and paleoseismology. K. S. Valdiya (JNCASR, Bangalore) delivered an excellent and stimulating talk on the application of classical tools such as structural geology and geomorphology to work out the active tectonics and the related structure in Cauvery Basin (which was earlier thought to be stable) and the Kumaon and Garwhal Himalayas.

G. D. Gupta (Joint Advisor, DST) discussed the current programmes taken up by DST in the field of seismology and active tectonics. DST's efforts to establish new digital seismic stations and Global Positioning Systems (GPS) in different parts of the country were highlighted in his brief presentation. He invited fresh proposals to work in new areas where paleoseismological investigations could be taken up to provide better insights to understanding earthquake processes. G. D. Gupta's eagerness to support new, exciting program-

mes provided a firm basis for more discussions on taking up new programmes in hitherto unexplored areas.

As the technical sessions progressed, R. N. Singh (Scientist-in-Charge, CMMACS, Bangalore) talked about the various contributions to the intraplate stress field and how they relate to earthquake mechanisms and the importance of understanding large-scale stress regimes prior to detailed paleoseismological work. John Paul (CMMACS, Bangalore) and later M. N. Kulkarni (SOI, Dehradun) presented some results and the concepts behind the use of GPS for studying crustal dynamics and active tectonics in India. M. N. Kulkarni also pointed out that a national, well coordinated effort is currently underway to systematize GPS data collection and archiving in our country for various applications including active tectonics. T. M. Mahadevan (Retd Director, AMD) pointed out that seismotectonics should be viewed in the context of the stress field generated by plate boundary forces. He went on to give very interesting insights into the deep continental structure of the Indian Shield and how it relates to the seismotectonics observed in parts of our country today. R. N. Iyengar (CBRI, Roorkee) presented a fascinating account of the search for evidence of Indian earthquakes from historical records and reported that records of 40 previously unaccounted

earthquakes were found. The third day of the short course was entirely devoted to using established and emerging methods in geochronology for paleoseismologic studies. Fascinating talks on the methods and potential for use in paleoseismological studies of luminescence and electron spin resonance dating by A. K. Singhvi (PRL, Ahmedabad) and T. K. Gundu Rao (IIT, Bombay) respectively gave the participants an excellent insight into the usage of emerging technologies for putting absolute dates on paleoseismic/neotectonic events. The talks were followed by discussion on how the present methodology could be further refined and improved by studying the deformation mechanisms in the rock samples used for the dating and the speakers acknowledged that it would open up exciting avenues for completely new research. G. Rajagopalan (BSIP, Lucknow) talked about the principles and techniques of radiocarbon dating method which is a widely used dating method in paleoseismic studies. R. R. Yadav (BSIP, Lucknow) pointed out how tree growth in active fault zones is affected by seismic events and how this can be used for paleoseismic studies by studying tree growth rings from active belts such as the Himalayas. K. R. Subrahmanya (JNCASR, Bangalore) contributed to the idea that the stable Indian shield is no longer stable and there is an east-west trending ridge along a zone of buckling near 13°N which exhibits microseismicity. Although no comprehensive mechanics of the development of all the active structures observed in the Cauvery basin have emerged yet, geomorphologic and other data from the region presented by

Valdiya and Subrahmanya seem to indicate that stresses resulting from the active convergence along the Himalayas have been responsible for active intra-plate deformation in the south Indian shield. R. Srinivasan (NGRI, Hyderabad) presented an exciting talk on some basic elements of structural geology that a paleoseismologist should be aware of. Citing two case studies from Killari and Koyna, he talked about monitoring helium gas escape from active fault zones as a potential tool to locate and study active fault zones. It was particularly striking to note from his talk that in faults defined by a zone rather than a sharp discontinuity, helium escape seems to be concentrated along the active parts of the fault zone. The lecture part of the course ended with some interesting case studies in India and abroad by K. S. Valdiya C. P. Rajendran and Kusala Rajendran. They gave some general pointers to where future work can be taken up. A course manual containing abstracts and more detailed notes on some topics, particularly dating techniques was, useful, but most participants were keen to have a more elaborate course manual. It was generally felt that university training itself is not adequate to take up state-of-the-art paleoseismological studies. Many expressed the need for more rigorous field training exercises.

The participants selected for training were also invited to talk about their own work and the near-extempore presentations showed that most of the participants were active researchers working on very interesting earth science problems. During discussions that followed, it became evident that a similar short course on some of the recent structural

geology techniques and concepts is urgently required. K. K. Agarwal (University of Lucknow) suggested that a short course covering more recent concepts in structural geology such as deformation mechanisms using microstructures, retrodeformable balanced cross-sections, critical wedge taper theory and its applications to compressive tectonics, numerical and analogue modelling, etc. would be highly beneficial.

The course ended with a field trip to Sivasamudram Falls about 120 km from Bangalore. The field trip was led by K. S. Valdiya and the participants got a first-hand experience of appreciating how geomorphological principles could be combined with highest order observational skills to work out the active tectonics in a region and the importance of field input into understanding deformation in rocks.

The greatest success of the course was perhaps the fact that it brought together a group of keen and active researchers who are excited about carrying out the best possible research in our country. Many potential areas were identified and foundations for future collaborations were laid during the discussion sessions. The impact of the course will probably be felt during the coming years, as the young researchers who benefited from this course work together to blend classical and contemporary ideas in earth sciences. The organizers, along with the DST must be heartily congratulated for organizing this course.

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