

and state agencies. The CSIR Centre for Mathematical Modelling and Computer Simulation provided a catalytic role in this endeavour by organizing the first national scientific workshop on 'Monitoring and Modelling of the Coastal Ocean: Towards an operational system for regulating waste disposal', at NAL, Bangalore during August 17-19, 1993. About 40 scientists from over 20 leading national institutions and R&D establishments participated in this workshop which underlined the growing concern for applying new scientific and computational approaches towards designing effective methods of waste disposal. A notable feature of the workshop was the enthusiastic participation of officers from the state regulatory agencies, notably, including B. Shivalingaiah, Secretary, Karnataka State Pollution Control Board and Yellappa Reddy, Secretary, Department of Environment and Ecology.

K. N. Raju, Acting Director, NAL inaugurated the workshop and V. K. Gaur delivered the presidential address followed by an introduction to the scientific programme by K. S. Yajnik, Head C-MMACS and C. R. Murthy, NWRI, Canada. The technical sessions covered important topics related to coastal processes (3 sessions), coastal models (2 sessions), thermal discharge (1 session), case studies (1 session) and software demonstration (1 session).

C. R. Murthy explained during the inaugural session the crucial role of coastal ocean research in efficient management of marine resources and environment. He also outlined the

modern techniques now used in coastal ocean studies in developed countries like Canada, and explained the physical processes that affect waste-disposal systems in the coastal ocean. He also presented several interesting results related to the parametrization of ocean diffusion processes.

P. C. Sinha described the extensive studies made at IIT, Delhi on modelling of circulation in the Hooghly estuary and V. Joshi from NEERI, Bombay on the evaluation of water quality management options for Malad creek using detailed computer simulation. This study examined the efficacy of various available field options for improving the creek water quality. T. C. Gopalkrishnan from Kodaikanal spoke on important features in numerical modelling of coastal dispersion, and also presented the results of a finite element model applied to a coastal region near Kuwait.

D. Srinivasan of IIT, Madras discussed the modern techniques of monitoring the coastal ocean and S. K. Dube and A. D. Rao, IIT, Delhi described the modelling studies made in Gulf of Kutch and Godavari estuary respectively. M. S. Phanikumar presented in some detail the methodology used in the studies at C-MMACS on modelling the hydrodynamics and levels of pollutant concentration in the vicinity of Bombay harbour. He also gave a few results on validation of the model.

G. N. Swamy, NIO, Goa spoke on dispersion processes and studies with reference to Indian coastal waters while

his colleagues, N. M. Anand and S. Mandal, described the software packages SAGARDIL (for marine outfall design) and DOLPHIN (for wave hindcasting studies).

T. M. Krishnamurthy, BARC, Bombay described modelling studies made to determine the concentrations of radio-nuclides in coastal waters as a result of an accidental release from a nuclear power plant. The model has been applied to predict the concentration profiles of Br-82 tracer used to follow the pathway of domestic sewage discharged into Colaba and Malda coastal waters of Bombay, while S. M. Rao explained the use of isotope tracers in sediment transport studies. T. P. H. Gowda, SJCE, Mysore spoke about modeling the fertilizer plant discharges into the Arabian Sea.

V. K. Gaur chaired the session on the concluding day of the workshop. There was a general discussion about the status and future of modelling activities related to the coastal ocean. Several recommendations have been made on the development of a national coastal ocean database, literature database, software development and application and coordinated field experiments and training workshops. It was also agreed that this type of workshop should be held once in every two years.

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## CORRESPONDENCE

# What should India be doing on the human genome?

We are responding to the write-up by J. Gowrishankar on the above subject (*Curr. Sci.*, 1993, 63, 705). To establish our bonafides, one of us was, perhaps, the first to suggest that India should invest on sequencing the entire human genome, at a time when the project was new and few in our country had heard of it.

The other of us is a co-author of, perhaps, the only detailed project submitted in this area in India, with emphasis on sequencing of the sex chromosomes.

Gowrishankar seems to be against a consolidated project on the sequencing of the human genome for the following reasons:

- (a) He is against it being carried out in the mission mode with earmarked funds as this work, in his opinion, does not represent a pressing national or social concern, nor is it a research project in the area of defence, atomic energy or Bhopal gas disaster and their likes (we do not understand the inclusion of

Bhopal gas disaster as a research project)

- (b) We are very thinly spread out with very few internationally competitive groups in any one field
- (c) Earmarking of funds for a project such as the sequencing of the human genome would lead to support of not so good science in our country.
- (d) Earmarking of funds cannot represent an additional appropriation.

We believe that the above arguments are untenable for the following reasons

- (a) Even a cursory review of the extensive literature on the human genome project and its implications not only for the progress of science but also in relation to major, social, medical and health issues, would show, even to a layman, that when the human genome project is completed, its direct results and fall-out would have an enormous and immediate impact on health and medical care and no doubt, perhaps a little later, on agriculture for the same technique that would be established for the sequencing of the human genome project could be used for the sequencing of the genomes of important food crops. (China has already embarked on a 15-year project on the sequencing of the entire rice genome under the direction of G. F. Hong of the Shanghai Institute of Biochemistry.) The anticipated benefits of this project, when one of us made the initial suggestion, were evidently much greater per unit money that was suggested to be invested on it, than was the case when India started investing on atomic energy or space when the countries in the West were far ahead of us in these areas than would have been the case with the human genome project. Further, whenever any new institution is set up, it has funds

earmarked for it. And wisdom and foresight often demand setting up of new organizations which do not, at the time they are set up, take care of a pressing natural or social concern but, in course of time become major determinants of progress. Our country's scientific history is replete with such examples. The human genome project will surely come into this category, specially if one realizes that the data collected by those investing in it are not likely to be available in entirety to those who have not contributed to it and are, therefore, not in a position to barter. The recent episode of one major power influencing another to make it go back on its promise to transfer cryogenic engine technology for our space programme, would be one example relevant to the future of the human genome project.

- (b) Were we less thinly spread out when we set up Departments of Atomic Energy, Space, Biotechnology, or Environment, all with earmarked funds? While, surely, some of these departments have done much better than the others, we do not believe that setting up of any one of them was a mistake. Where the departments have failed, it is because of bad decisions and not because of the lack of availability of resources.
- (c) Has the support of earmarked funds for atomic energy, space, or development of advanced computing led to worse science than the average in the country which is a consequence of the peer review system to which Gowrishankar refers to? In our experience, if one were to take the realities of the Indian situation into account, neither the earmarking of funds nor the peer-review system can ensure (or has ensured) good performance in science and tech-

nology. Whenever success has been achieved, it has always been primarily for other reasons such as good leadership. And crisis of leadership in science in India is well-known

- (d) Earmarking of funds always represents, at least partly, an additional allocation. That is what the planning process is about, and that is why we have a distinction between plan funds and non-plan funds. We, in all humility, would like to suggest that Gowrishankar acquaints himself with the manner in which a planned economy like ours works. If funds have ever been cut in our country for worthwhile scientific work, it has never been on account of investment in earmarked funds elsewhere, it has always been for other reasons which have had, generally, nothing to do with science.

We can support our above statements with numerous examples based on personal experience and available documentation and would be happy to do so for anyone who is interested.

We should like to conclude by stating that one of the greatest mistakes we have made in regard to science is not to have invested in the human genome project when the suggestion was initially made, and we would never be able to compensate for it adequately. We feel intensely concerned because of our primary commitment to our country and its people.

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