

HUMAN RESOURCES TRAINING IN COASTAL SCIENCE

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India has a long coastline of 6,500 km and an Exclusive Economic Zone (EEZ) with an area equivalent to two-thirds of its land area. The increasing demands of the growing population on limited land resources, and heavy urbanization, have led to exploitation of coastal marine resources (Nayak, 1986). This exploration and exploitation poses a challenge that calls for proper human resources training and appropriate technology. Recent technological advances, specially in electronics, remote sensing and computers, have revolutionised marine research. As a result, teaching and training programmes in marine science need continual adaptation and updating, in order, on one hand, to incorporate the new knowledge and technology, and on the other, to keep abreast of the changing potentials regarding marine resource exploitation and the impact of human activities on the marine environment (UNESCO, 1988).

The coastal area includes the coastal waters, the continental shelf, adjacent shorelands and water bodies influenced by and in proximity to the shoreline. They are most productive ecological units and are also most desirable areas for human habitation (Ocean Year Book, 1978). Training of manpower needed by different organizations engaged in exploration and exploitation of coastal zone, should be well conceived with the future in mind. This is all the more important in view of the additional responsibilities that coastal nations are assuming under the new ocean regime.

Human resources development for coastal marine science in India is mostly through ten maritime universities - Annamalai, Andhra, Bombay, Berhampur, Calcutta, Cochin, Goa, Karnataka, Kerala and Madras which offer a variety of postgraduate courses in different branches of marine science. The Institute of Remote Sensing (IRS) is supporting a M. Tech Programme in Remote Sensing at Anna University.

There are several other universities which have contributed significantly to fundamental research in marine sciences. The School of

Environmental Sciences - Jawaharlal Nehru University, Delhi carries out studies on estuarine physics, marine geology and pollution aspects and also conducts an aerial photo-interpretation course to M.A. Geography students. Work on larval studies and biochemistry of marine fouling organisms have been done at the Marathwada University. The Universities of Madurai, Kolhapur and Punjab have research facilities for different disciplines of marine science (Rao *et al.*, 1986). Aligarh University offers M. Tech Course in Remote Sensing Applications.

Among the Agricultural Universities, the Konkan Krishi Vidyapeeth (KKV), near Ratnagiri has been carrying out research on fishery biology and aquaculture. The Fisheries College at Tuticorin and the Faculty of Fisheries of the Kerala Agricultural University, Trichur, are actively engaged in teaching and research in fishery science and technology. The College of Fisheries, Mangalore, awards postgraduate degree in Fishery Sciences. The Central Institute of Fisheries Education at Bombay offers special courses in Fisheries Technology and Management. Thus, today most of the coastal universities have active teaching/research programmes leading to Master's and Ph.D. degrees in marine biology, marine geology, marine chemistry, marine meteorology, oceanography and fishery sciences (Rao *et al.*, 1986).

The role of Indian Institute of Technology (IIT's) and other Regional Engineering Colleges in teaching special courses on marine engineering and technology has been very encouraging. The IIT at Bombay offers a course leading to postgraduate diploma in Dock and Harbour Engineering in addition to research facilities in marine geology, geochemistry, fluid mechanics and offshore structures. The IIT at Madras awards M. Tech degree in Ocean Engineering. It is also an advanced Centre for study on design component of Ocean Thermal Energy Conversion (OTEC) plant, marine electronics, instrumentation and naval architecture. At the IIT, Delhi, research on modelling related to marine meteorology and storm surges is going on. Also facilities are available for carrying out geotechnical work and on the design of offshore structures. The IIT at Kharagpur is an advanced Centre for Naval architecture and also has training and research facilities in marine geology and marine geochemistry. The IIT of Kanpur offers regular M. Tech programmes in Remote Sensing. The Karnataka Regional Engineering College, Suratkal offers M. Tech. degree in marine structures and coastal engineering. Some R & D organisations like Defence, CSIR, ICAR, CWPRS, GSI, BARC, TIFR and CESS also deal

with different aspects related to coastal marine sciences either directly or indirectly.

The Central Marine Fisheries Research Institute (CMFRI) is the nodal organization for R & D concerned with all aspects of marine fisheries including mariculture. Postgraduate education and research programmes in mariculture were initiated in 1979 with FAO/UNDP assistance. The Krishi Vigyan Kendra of CMFRI functions as a vocational training centre at the grass root level, conducting need based training courses to small and marginal farmers, landless labourers and unemployed youth. The main theme of training has been prawn and fish farming in coastal areas. On an average 1,000 persons are trained per year (CMFRI, 1987 and 1988).

The Central Institute of Fisheries Education (CIFE) at Bombay conducts specialised courses on all aspects of fish technology and fishing crafts and gears. Their courses are chiefly to train senior level executives of state fisheries and fisheries organisations. Courses are available at CIFE for meeting the multidisciplinary backing up of the developmental needs in marine and coastal fisheries (Dwivedi *et al.*, 1986).

The National Institute of Oceanography (NIO) is the premier organization for R & D in all aspects of oceanography, including coastal marine science on a multidisciplinary level. This requires not only scientists and technologists but also supporting staff on land in the form of base facilities, workshops and laboratories. The NIO has recruited 50 scientists/engineers with various background and trained them during 1982-'83 for oceanographic work. A multidisciplinary approach in this training is a key factor. The NIO also conducts short-term/long-term training programmes on national and international levels on sponsorship basis. Expertise, capabilities and infrastructural facilities are available at NIO to cater to training needs in oceanography.

The Department of Ocean Development (DOD) organized a series of workshops between 1982 and 1986 with a view to generate manpower development in India. During these workshops constraints faced by the universities by way of infrastructure facilities, sea going vessels and inadequate curricula were discussed. It is estimated that atleast 1,000 skilled and talented scientists/engineers/technicians will be required every year from now onwards in order to be self reliant and to undertake different R & D activities in Marine Sciences.

It is of importance for sustainable development of living and non-living marine resources that ocean and coastal zone uses develop

under a system of integrated planning and management. Attention should be given to future needs, particularly relating to training and education for proper use, protection, and conservation of marine and coastal ecosystems. Some major areas are listed below:

Sea-Level Rise

Today we are concerned with consequences of sea-level rise due to global warming, as a result of green house effects. We need to collect data not only on physical, chemical, biological factors but also on geological and paleoclimatic changes, based on records from the seabed, etc. (Nigam, *et al.*, 1990). The study of sea-level rise requires a multi disciplinary approach.

Careful monitoring of sea-level changes and assessment programmes on their possible impacts are necessary and need to be on a global, regional, subregional and local basis. It is also necessary to strengthen networks among scientific institutions for the supply of information on coastal oceanography, meteorology, hydrology and marine ecology in order to properly assess sea level rise impacts and related phenomena (UNESCO, 1988).

Information on coastal processes is of great importance in any development plan because of their strong influence upon marine biota, sea-water circulation, water quality sedimentation and erosion in coastal regions. Knowledge of the nature of sedimentary regime can help in understanding the origin, pathways and fates of suspended matter. A good knowledge of the sedimentary processes, including transportation and deposition, is required for coastal development planning (UNESCO, 1988). Training subjects to be included are monitoring, especially by satellite observations and aerial-photography interpretation, modelling and simulation of coastal processes, field measurements, offshore observations, land-sea interactions and currents.

Pollution of Coastal Zones

Technological capabilities need to be developed for monitoring and control of pollution along our coasts as it directly or indirectly affects living resources. The problems in some cases are aggravated by the lack of proper management and by the lack of training for monitoring, as also for abatement. At present, and for the future, there is need for information, education, inter-calibration and training of people for a proper

evaluation and assessment of water pollution in coastal marine areas (UNESCO, 1988).

Our knowledge and understanding of the land-sea and ocean-atmosphere interactions are vital for planning and management. In the coastal zone, physical and chemical oceanographic parameters are, to a large extent, influenced by the form of the coastline and its topography, as well as by meteorological and climatic conditions. Training should focus on field measurements concerning exchange between the sea and the atmosphere, as well as on modelling and simulations (UNESCO, 1988).

Regulations should be established for the marine environment which would provide for different types of allowable uses in designated marine areas. These regulations should include provisions for the allocation of different zones earmarked for such activities and uses and should include zones of protection and conservation.

During the next 20 years, there would be more concentration in coastal engineering because of its important role towards improvements in sea trade, ports and harbour development, fisheries development and waste disposal, to name a few most significant ones. Recreation and development of various industries are vital for economic development. Well planned monitoring and research programmes need be taken up with reference to data collection on waves, currents, tides, shore changes, sediment transport, etc. (Varadachari, *et al.*, 1981) to meet the above needs fully.

The Andaman - Nicobar Islands, in the Bay of Bengal, and the Lakshadweep islands, in the Arabian Sea, exhibit certain unique characteristics. They contain exotic varieties of flora and fauna, and their coral reefs and atolls are of specialized nature. Preservation of such ecosystems are essential for mankind. Fortunately, at present, there are no pollution hazards in those islands. However, considering the future developmental programmes with respect to trade, commerce, industries and sea route transport, it is more than likely that pollution problems will certainly crop up in the near future (Ocean Year Book, 1978). It would be appropriate to train and prepare the island population for handling practical issues like sewage treatment plants, construction of waste disposal systems, pollution monitoring and employment of solar dryers, desalination plants and other conservation measures.

Underwater technology is fast developing not only for mining in deep waters but also as a useful tool for tackling various problems like

construction of offshore platforms, underwater pipelaying, archaeological survey and study of undersea fauna and flora in natural conditions. We have very little trained manpower in India today in this field and we have to learn a good deal yet, about underwater cinematography and surveying. For a country of India's size, it is estimated that at least 40-50 scientists trained in underwater exploration, documentation, retrieval and conservation techniques will be needed every year. Co-operation between Indian Navy, universities and NIO is essential for such training programmes. The NIO has a team of trained scientist divers and has made available software and hardware necessary for exploring the coastal waters. A lot more is to be done in this field.

Scientific problems relevant to the sustainable development and management of the coastal zone, the oceans and their resources cannot be separated from socio-economic and cultural practices prevalent in the country as they have been derived from long-term traditional uses.

Economic, and potential social uses of the coastal zone towards the 21st century will increase because of expanding population pressures, improvement in technologies and equipments, leading to an easier access to the sea, as well as continuing demands for the use of coastal resources. There is also the expanding industry (need based) for recreation and tourism.

The concepts of coastal development and management are very broad, requiring inputs from pure, applied and social sciences. Presently a number of governmental and non-governmental organizations, universities and scientific groups are carrying out work in the field of coastal resources utilisation. Such works generally deal with scientific and technical aspects and do not attempt seriously to relate economic issues of coastal management with overall general development (Ocean Year Book, 1978).

The coastal marine science, in the years to come, should be a hybrid concept between elements of regional analysis and environmental management. Elements of regional analysis would include aspects like how to allocate physical capital with respect to settlement, improving basic amenities, establishment of industrial plants, etc. in space. Environmental management is of course crucial, since the coastal zone is most productive and highly conducive for human settlement. The problems in coastal zone management are:

- i) interactions among the use of the coast by two or more users can physically conflict due to limited space (e.g.) where a dredge for

mining or channel clearing cuts or submarine pipeline or cable or a fishing harbour forming a base for offshore oil activities,

- ii) destruction or deleterious modifications of valuable environment. Coastal marine environment may contain number of low energy environments which are valuable as breeding/nursery grounds for shrimps and fishes. These environments include wetlands, marshes, coastal peat and mangroves. There is always a strong pressure to develop these areas for commercial and residential purposes,
- iii) pollution of coastal and estuarine waters results in health hazards to human beings, amenities and fisheries.

Problems in coastal zone management are due to lack of a well defined government policy towards landuse, allocation and resource utilisation, lack of public awareness, political considerations regarding coastal developmental activities and above all, the financial restraints, which actually contribute only to outweigh the benefits (Ocean Year Book, 1978).

Human resources development in coastal marine science should be mostly through universities in co-operation with NIO, CMFRI, CIBA, CIFE, CIFT, etc., for practical field and ship-board training on oceanographic studies. The curricula must be tailored to meet the demands of user agencies like GSI, NIO, CMFRI and CIFE, of various shipyards like MDL, HSL, GSL and the commercial undertakings like ONGC, OIL, MECON and EIL. Constraints faced by the universities teaching marine science on a multidisciplinary level are many and unless undertaken very as a co-operative venture, it will not be fruitful or useful.

Most of the research and user organizations recruit personnel who have passed the academic course on basic science and then retrain them on their own to suit their needs.

The training strategy for marine science must be based on the fact that with fast developing technology, there will be corresponding changes in the requirements of skills. The following are recommended:

- Organising Refresher Courses' every year at NIO/CMFRI/CIFE/IITs for university teachers to expose them to recent advances in marine sciences in chosen fields depending upon the curriculum that is being offered; otherwise, it will be most advisable to create a national facility for training teachers/researchers on a continuing basis.

- Marine science is multidisciplinary in nature and so efforts are to be made to provide students with basic knowledge to facilitate a broader understanding and to allow specialization only to understand the processes in depth.
- Legal, financial and other supports to be provided to teaching institutions to enhance infrastructural facilities.
- Use of computers in education and research needs to be encouraged. Students to have full access to computers. Modelling techniques to be incorporated into the basic marine science curriculum.
- Create a central data collection and distribution facility under a team of trained personnel to serve all interested organizations. NIO can provide assistance in this area.
- Marine biotechnology holds the greatest promise for marine pharmaceuticals, genetic engineering of marine/estuarine animals and plants for food production. Workshops, seminars, and short-term training courses to be organised for molecular biologists for familiarization with workings of marine system and marine scientists to learn biotechnology (Walch, 2000). Training in this emerging area is a must.
- Through application of remote sensing it is possible to derive useful data from the marine environment. Next decade will see the launch of many more satellites. If one has to benefit from ocean satellite programmes, there must be trained personnel to take up the responsibility (Robinson, 2000). Training facilities are available at Indian Space Research Organization (ISRO) and training programme could be intensified through ISRO.
- Training is necessary in analytical techniques for the assessment of pollution, dispersion - dilution of pollutants in different types of coastal waters and use of devices for coastal marine pollution. To obtain quality and reliable data, intercalibration exercises need be organized periodically for teachers/researchers / planners / managers concerned with pollution control. NIO has training capabilities in this area.

- **Encourage IITs, Polytechnics and Engineering Units to develop indigenous equipments/instruments for use in coastal zone and make these available to teaching institutions/user organizations.**
- **Train younger generation by introducing marine science at the undergraduate level. Whenever possible marine science course be made available to students even in universities which do not offer the subject.**
- **Education and awareness programmes for the common man in the use of coastal resources through non-governmental voluntary organizations with effective communication means.**
- **Training courses to be developed specifically for managers and politicians who have marine responsibilities to encourage understanding and awareness of problems/potentials in the coastal zone.**

The potential uses of the coastal zone are diverse. Our demands will continue to increase, for settlements, for food, industrial developments and for recreation in an undisturbed environment. We will naturally look upto the marine environment to meet all these needs. Marine Science education must foresee areas of concern beyond 2000. Opportunities should be provided to teachers to ensure (for future generations) better basic understanding and multidisciplinary orientation towards coastal environment. We need trained personnel at all levels - technicians, technologists, researchers, planners and managers, for all of which facilities have to be provided on a continuing basis (Baker, 2000). India has certainly the full capability and required facilities to augment our own manpower development needs and it can also assist other developing countries in this regard.

REFERENCES

- Baker, J.T., in Year 2000 Challenges for Marine Science Training and Education Worldwide, Unesco Reports in Marine Science No. 52, Unesco, Paris, 129. Central Marine Fisheries Research Institute, 1987 and 1988. Annual Report.
- Dwivedi, S.N. and K.K. Gosh, 1986. In: Proceedings of the Workshop on Marine Sciences Curriculum at the Postgraduate level, held at Goa, 13-14 February.

- Nayak, B.U., 1986. Manpower for Marine Technology and Ocean Engineering Development in India by 2000 A.D. Paper presented on the occasion of Engineers' Day and the Annual Day of the Institute of Engineers (India), held at Panjim on 15th September, 1986.
- Nigam, R., N.H. Hashimi and M.C. Pathak, 1990. Journal of Marine Archaeology, Vol. 1: 16-18.
- Ocean Year Book, 1978. Vol. 1, edited by E.M. Borgese and N. Ginsburg (University of Chicago Press, Chicago and London) 890.
- Rao, T.S.S., Sumitra-Vijayaraghavan, and J.P. Royan, 1986. In: Proceedings of the Workshop on Marine Sciences Curriculum at the Postgraduate level, held at Goa, 13-14 February.
- Rao, S.R., 1990. Journal of Marine Archaeology, Vol. 1: 1.
- Robinson, I., in Year 2000 Challenges for Marine Science Training and Education Worldwide. Unesco Reports in Marine Science No. 52, Unesco, Paris, 129.
- Sardana, M.M.K. and B.R. Subramanian, 1988. In: Island Development edited by S.N. Dwivedi and P. Chaturvedi (India Association for Advancement of Sciences) 244.
- UNESCO, 1988. Year 2000 Challenges for Marine Science Training and Education Worldwide. Unesco Reports in Marine Science No. 52, Unesco, Paris, 129.
- Varadachari, V.V.R., T.S.S. Rao, Sumitra-Vijayaraghavan and J.P. Royan, 1981. Education, Training and Manpower for Ocean Development, p. 14. Paper presented at the Workshop on Education, Training and Manpower for Ocean Development, at Waltair, 30 September - 1 October.
- Walch, M., in Year 2000 Challenges for Marine Science Training and Education Worldwide. Unesco Reports in Marine Science No. 52, Unesco, Paris, 129.

