

Long-term data on coastal pollution and dissemination to academic and research communities

B. R. Subramanian

This article provides details on a marine pollution monitoring programme, namely Coastal Ocean Monitoring and Prediction System with a long-term database being operated by the Ministry of Earth Sciences, Government of India. This programme has been operational since 1991. Under the programme, data on 25 pollution-related parameters are being collected at about 83 locations with the involvement of leading research institutions and universities in the country. The data collected have been evaluated and organized in the form of a database. The data facilitate analysis of trends of chemical and biological parameters and reveals effectiveness of pollution control measures initiated by the concerned authorities.

Keywords: Database, marine pollution, monitoring programme, prediction.

Programme for collection of data on marine pollution

THE past few decades have witnessed demographic pressure and rapid industrialization in the coastal areas of our country. This is due to obvious reasons of availability of infrastructure like ports for import of raw materials and export of finished products, immense avenues to use the sea as a place for waste disposal by municipalities and industries, and more so, use of sea water for industrial cooling. Disposal of raw sewage and untreated waste mostly from small and medium-scale industries has affected the quality of coastal waters. In certain locations like the coastal waters of Mumbai, the deteriorated water quality has been threatening the existence of marine life. A thorough understanding on health of the coastal waters through a systematic pollution monitoring programme was felt essential in the 1980s and accordingly, the erstwhile Department of Ocean Development (DOD) along with the Central Pollution Control Board initiated a pollution monitoring programme in 1986, with a reconnaissance survey for three years, collecting data on pollution parameters at about 120 locations covering estuaries and coastal waters. After an assessment of the data collected, pollution monitoring was restricted to the coastal waters and in 1991, the DOD launched a programme, namely the Coastal Ocean Monitoring and Prediction System (COMAPS) to focus on monitoring pollution at 70–83 locations as well as to develop models to predict trends of

pollution for selected parameters at a few locations in the country. Data relating to pollution monitoring programme are being collected by a group of R&D institutions, and the Integrated Coastal and Marine Area Management Project Directorate (ICMAM-PD), Ministry of Earth Sciences has developed a database containing data on 25 pollution-related parameters. The database is hosted by the Indian National Centre for Ocean Information Service (INCOIS), Hyderabad in its website (www.incois.gov.in).

The pollution monitoring programme has supportive components such as: (i) Collection of data on land-based sources causing marine pollution, such as quantity of waste discharged to coastal waters from selected major towns/cities on aspects like domestic, industries, agriculture, aquaculture, etc. (ii) Inter-laboratory data comparison exercises on selected chemical parameters to institution involved in the monitoring programme to ensure data quality. (iii) Development of a structured database to archive the data collected from the monitoring programme from 1991 till date, and provide baseline data (in Oracle, hosted in the website) for dissemination to users. (iv) Determination of waste assimilative capacity of coastal waters using predictive models.

Parameters and locations of monitoring marine pollution

Parameters

Based on inputs from the State Pollution Control Boards and experts, 25 pollution-related parameters were identified for collection of data. The details of parameters are listed below.

The author is in the Integrated Coastal and Marine Area Management Project Directorate (Ministry of Earth Sciences), Pallikaranai, Chennai 600 100, India. e-mail: brs@icmam.gov.in

GENERAL ARTICLES

Table 1. Methods adopted and their sensitivity

Parameter	Technique	Sensitivity	Precision	Reference
Salinity	Mohr–Knudsen argentometric titration method	PSU	± 0.02	1
Dissolved oxygen (DO)	DO in sea water by Winkler's method.	0.005–0.008 mg/l	± 0.003	1
Nitrite	Nitrite by diazotization	Up to 10 µM	± 0.02 µM	2
Ammonia	Indo-phenol method	0.05–40 µM	± 0.092 µM	2
Inorganic phosphate	Molybdenum blue method	0.01–28 µM	± 0.2 µM	2
<i>Escherichia coli</i>	Membrane filter technique (M-FC agar). Blue colonies	Luxuriant		3
<i>Streptococcus faecalis</i>	Spread plate method (M-Enterococcus Agar). Maroon-coloured colonies	Luxuriant	This medium is 100% selective for faecal streptococci even in the highly polluted sample	4
Chlorophyll <i>a</i>	Spectrophotometric method	0.02–5 µG	± 0.26	1
Phytoplankton	Plankton net of 20 µm			Standard counting methods
Zooplankton population	Plankton net of 64 µm. Sedgewick–Rafter counting chamber			5

(a) Water quality: Temperature, salinity, pH, suspended solids, biochemical oxygen demand (BOD), inorganic phosphate, nitrite, nitrate, ammonia, total nitrogen, total phosphorus, silicate, petroleum hydrocarbons and microbiological parameters.

(b) Sediment: Texture (sand, silt, clay composition), total organic carbon, heavy metals (Cd, Pb, Hg) and microbiological parameters.

(c) Biological parameters: Primary productivity, chlorophyll *a*, phaeophytin, qualitative and quantitative aspects of phytoplankton, zooplankton and benthic organisms.

(d) Microbiological parameters: Total viable counts, total coliforms, faecal coliforms, *Escherichia coli* (ECHO), total Vibrios (VLO), *Vibrio parahaemolyticus* (VPLO), *Vibrio cholerae* (VCLO), *Salmonella* (SLO), *Shigella* (SHLO), *Proteus klebsiella* (PKLO), *Pseudomonas aeruginosa* (PALO) and *Streptococcus faecalis* (SFLO); (LO denotes like organisms).

Standard sampling procedures are being adopted for collection of samples and analysis of chemical parameters is being done according to methods described in Table 1.

Monitoring locations

Details of locations along with periodicity where the data on 25 pollution-related parameters have been collected are given in Table 2. These locations cover mouth of major estuaries and creeks located close to and 1, 3, 5, 10 km in the sea. At present the data are collected at 83 locations and they fall under 2 categories, viz. (i) 3 or 4 seasons a year which covers locations where continuous or signifi-

cant sources of pollution exist, and (ii) once a year where there are few or no prominent sources of pollution. The numbers of these locations are changed periodically and are based on trends of increase or decrease of pollutants observed over a period of few years. Where no or little changes occur over a few years, they are discontinued and replaced with new locations.

Institutions involved in data collection

During the period 1991–2007, various institutions such as the National Institute of Oceanography (NIO), Goa and its Regional Centres at Mumbai, Kochi and Visakhapatnam; Central Salt and Marine Chemicals Research Institute, Bhavnagar; Centre for Earth Science Studies, Thiruvananthapuram; Central Pollution Control Board (CPCB), Kolkata; Institute for Minerals and Materials Research, Bhubaneswar; Central Electro-Chemical Research Institute Regional Centres at Chennai, Tuticorin and Port Blair, NIOT Centre at Port Blair and Centre of Advanced Study in Marine Biology, Annamalai University were involved in monitoring collecting data on pollution parameters in different maritime states during various periods.

Regional Centre NIO, Kochi, Goa; CPCB, Delhi; National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram; Institute for Ocean Management, Anna University and ICMAM-PD were involved in the supporting activities, viz. microbial reference facility, data on sources of land-based pollution, inter-laboratory comparison exercises and database development during various periods.

Table 2. Pollution monitoring locations

State/Union territory	Locations
Locations for monitoring 3 or 4 seasons in a year	
Gujarat	Veraval, Hazira
Maharashtra	Thane creek
Goa	Mandovi
Karnataka	Mangalore
Kerala	Kochi, Veli
Tamil Nadu	Ennore, Cuddalore, Tuticorin
Puducherry	Puducherry
Andhra Pradesh	Visakhapatnam, Kakinada, Pyde Bhimavaram
Orissa	Mahanadi, Paradip, Puri
West Bengal	Sandheads, Hooghly estuary, Haldia port
Andaman	Port Blair
Locations for monitoring once a year	
Gujarat	Mundra, Kandla, Vadinar, Okha, Dwarka, Porbandar, Pipavav and Alang
Diu	Diu
Daman	Daman
Maharashtra	Tarapur, Bassein, Versova, Mahim, Mumbai, Thal, Murud, Dabhole, Ratnagiri
Goa	Marmugao, Zuari, Candolim, Valsao
Karnataka	Karwar, Honnavar, Chitrapura
Kerala	Kasargod, Cannanore, Calicut, Ponnani, Alleppey, Kayamkulam, Quilon, Paravur
Lakshadweep	Kavaratti
Tamil Nadu	Chennai Harbour, Cooum, Muthukadu, Karaikal, Nagapattinam, Thondi, Uchipuli, Mandapam (Gulf of Mannar), Vembar, Arumuganeri, Koodankulam, Kanyakumari
Andhra Pradesh	Krishnapatnam, Machilipatnam, Kalingapatnam, Bhimunipatnam, Gautami-Godavari Point
Orissa	Chandipur, Dhamra, Konark, Chilka, Rushikulya, Gopalpur
West Bengal	Digha, Diamond Harbour, Saptamukhi, Matla

Database on pollution parameters and availability to academic and research communities

A database containing details on location, sampling depth, stations and data of physical, chemical and biological parameters listed as above, has been developed using Oracle. At present, data updated for different years is available at the INCOIS website, for the 41 locations mentioned below and they will be updated periodically. Database for other locations is being finalized.

Further, data up to 2003–2004: Okha, Porbandar, Daman, Hazira, Mahim, Matla, Nizampatnam and Koodankulam.

Data up to 2007–2008: Puri, Konark, Gopalpur, Rushikulya, Pulicat, Mahabalipuram, Muthukadu, Karaikal, Thondi, Uchipuli, Vembar and Kavaratti.

Data up to 2007–2008: Karwar, Honnavar, Udipi, Chitrapura, Mangalore, Kasargod, Cannanore, Calicut, Ponnani, Cochin, Alleppey, Kayamkulam, Neendakara, Paravur, Veli, Ennore, Puducherry, Mandapam (Palk Strait), Mandapam (Gulf of Mannar), Arumuganeri and Kanyakumari.

A glance through the database reveals that there are data gaps for few months in a year and also for a few parameters for a particular location, which is mainly due to several field and laboratory constraints. The data can be accessed freely by the Indian academic and research communities from the INCOIS website after formal regis-

tration with terms and conditions to use the data. Data for commercial use is also available on payment basis.

Data for public information

The status of pollution at a few locations of public interest such as Hooghly, Paradip, Visakhapatnam, Kakinada, Pyde Bhimavaram, Ennore, Puducherry, Cuddalore, Tuticorin, Kochi, Mangalore, Zuari, Mandovi, Thane creek, Versova, Mahim, Bassein, Hazira and Veraval for parameters such as nitrate, ammonia, phosphate and bacteria is provided for public view in the website of ICMAM-PD (www.icmam.gov.in). The water quality data being updated periodically are compared with those of the Andaman sea and inferences are drawn on the status of pollution.

1. Strickland, J. D. H. and Parsons, T. R., *A Practical Handbook of Sea Water Analysis*, Fisheries Research Board, Canada, 1972, vol. 167, 2nd edn, p. 310.
2. Grasshoff, K., Ehrhardt, M. and Kremling, K., *Methods of Sea Water Analysis*, Verlag Chemie, Weinheim, Germany, 1999, 3rd edn.
3. Gledriech, Clark, Huff and Best, J. A. W. W. A., **57**, p. 508.
4. Gledriech, E. E, Clark, H. F., Huff, C. B. and Best, L. C., Faecal coli form organism medium for the membrane filter technique. *J. Am. Water Works Assoc.*, 1965, **57**(2), 208–214.
5. Burkwall, M. K and Hartman, P. A., Comparison of direct plating media for isolation and enumeration of enterococci in certain frozen foods. *Appl. Microbiol.*, 1964, **12**, 18–23.

Received 22 December 2009; revised accepted 18 October 2010