

CHEMICAL CHARACTERISTICS OF THE INSHORE WATERS IN VELSÃO BAY (GOA)

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ABSTRACT

The present study was carried out from September 1973 to January 1975 at two stations in Velsão Bay where the industrial effluents from Zuari Agro Chemicals are discharged.

The chemical composition of water in Velsão Bay showed high nutrient concentrations. The total arsenic concentration also showed very high values, which might be due to the influence of the effluent discharge from the fertilizer factory. The results are discussed in the context of monitoring the quality of inshore waters of Goa.

INTRODUCTION

The rapid growth of industrialization in any country, apart from its beneficial effect, creates environmental problems. Unless these are checked in time their long term effect becomes hazardous to human health. Therefore, consistent monitoring of the environment is essential to determine the quality of water.

Soon after the fertilizer factory (Zuari Agro Chemicals) at Velsão, Goa, went into production, intermittent fish mortality was reported adjoining the outfall in the Velsão Bay. This made it necessary to start a monitoring programme by National Institute of Oceanography, under the leadership of Dr. S. Z. Qasim, Director, NIO. The main components of the effluent were nitrogenous with arsenic compounds. The nitrogenous compounds are known to create problems primarily due to the presence of ammonia (Mohanrao and Subrahmanyam, 1973) and arsenic is one of the toxic trace metals and this being a cumulative poison, its discharge should be totally avoided in the sea (Haistead, 1972).

Parulekar and Selvakumar (1975), Kurup *et al* (1975) have studied the biological and physical characteristics of Velsão Bay, respectively, but there is no prior information available on the chemical characteristics of the water of this region.

MATERIAL AND METHODS

The water samples were collected from the surface at two locations, A and B in the Velsão Bay (Fig. 1). The point A was at the discharge point of the effluent while the point B was 500 meters away from A along the shore. Chemical and physical observations included temperature, pH, total alkalinity, salinity, dissolved oxygen, inorganic phosphate, nitrate, nitrite, ammonia and inorganic arsenic.

Salinity, total alkalinity and dissolved oxygen were measured by standard methods described by Strickland and Parsons (1968).

Inorganic phosphate was determined by the ascorbic acid-potassium antimonyl tartarate method of Murphy and Riley (1962).

Nitrate, nitrite and ammonia were determined using standard procedures, Korro-leff (1969), Bendschneider and Robinson (1952), and Grasshoff (1964).

Inorganic arsenic was determined using the spectrophotometric method of Johnson and Pilson (1972).

RESULTS AND DISCUSSION

The results obtained at the two locations A and B are shown in Table I and Table II.

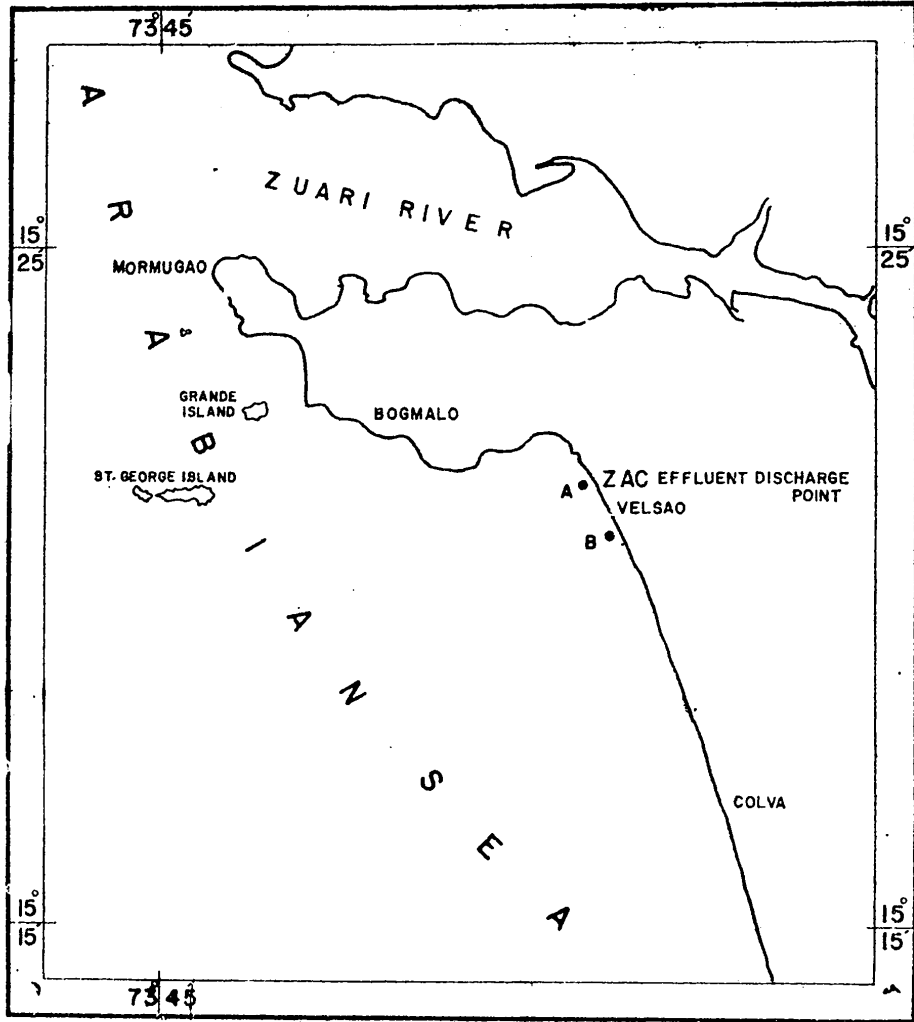


Fig. 1 — Map showing the station locations.

Hydrography: In general, the physico-chemical features gave a diverse picture. The physical characteristics such as temperature and salinity except for showing regular seasonal changes did not exhibit any erratic variation at the two locations. The temperature and salinity values ranged between 27°C to 30°C and 17°/00 to 35°/00, respectively. The fluctuations in the concentration of dissolved oxygen at both the locations also did vary significantly. The values ranged between 3.49 ml/l to 5.71 ml/l. The pH at location A varied from 7.8 to 8.6 whereas at B, it varied between 6.8 to 8.4. The high values of pH at location A was probably due to the presence of ammonia.

Phosphorous and Nitrogen Compounds: Inorganic phosphate was generally high. The values ranged between 0.05 $\mu\text{g-at/l}$ to 26.84 $\mu\text{g-at/l}$ at both the locations as compared to a far away station where the average value was less than 1 $\mu\text{g-at/l}$. The high concentration of inorganic phosphate in the vicinity of the discharge point was due to the effect of the effluents which used acid containing phosphorus for washing the tanks to prevent bacterial growth.

The $\text{NH}_4\text{-N}$ values also showed wide variations at A and B. The values ranged between 2.90 $\mu\text{g-at/l}$ to 174 $\mu\text{g-at/l}$. These values were very high as compared to those in the inshore waters which under normal

Table 1. Surface concentrations of Physico-Chemical parameters at the discharge point of ZAC (A)

Date	Temp. °C	S°/oo	0 ₂ /l ml	pH	PO ₄ ³⁻ -P µg-at/l	NO ₃ ⁻ -N µg-at/l	NO ₂ ⁻ -N µg-at/l	NH ₄ ⁺ -N µg-at/l	inorg. As µg/l.
6-09-73	29.4	30.84	—	7.90	4.52	—	—	53.58	123.40
15-10-73	29.5	32.80	—	7.90	3.42	—	—	—	699.80
6-11-73	29.2	33.96	—	7.70	2.82	26.35	—	11.44	4.41
22-02-74	29.9	32.92	5.15	8.40	2.09	50.58	8.86	2.90	26.43
21-03-74	29.5	33.08	4.39	8.40	1.92	46.16	3.66	5.37	68.40
24-05-74	29.5	35.25	4.14	6.80	2.28	22.57	13.99	8.10	—
5-06-74	29.9	35.34	4.26	7.40	2.53	27.50	37.50	21.99	3.00
18-07-74	27.2	21.11	4.94	7.90	7.00	260.00	13.33	7.30	18.00
16-08-74	26.9	18.55	4.43	7.50	4.50	55.05	12.99	24.22	90.00
6-09-74	29.0	15.79	3.49	8.40	16.75	11.03	36.33	10.78	24.40
14-10-74	27.0	17.37	3.98	7.80	26.84	271.20	22.84	174.24	7.48
11-11-74	28.0	28.28	4.70	8.10	1.89	26.55	15.05	10.45	131.18
13-12-74	27.0	32.97	4.36	8.40	11.40	12.01	32.25	13.61	11.24
9-01-75	27.0	32.84	4.03	8.00	3.91	—	42.79	10.76	—

Table II. Surface concentrations of Physico-Chemical parameters at (B)

Date	Temp. °C	S ² /oo	O ₂ ml ² /l	pH	PO ₄ ⁻³ -P μg-at/l	NO ₃ ⁻ -N μg-at/l	NO ₂ ⁻ -N μg-at/l	NH ₄ ⁺ -N μg-at/l	inorg. As μg/l.
6-09-73	29.2	31.02	4.70	7.90	0.05	—	—	3.43	16.52
15-10-73	29.0	32.46	4.54	7.80	1.48	—	—	—	583.20
6-11-73	29.0	32.17	4.37	7.80	1.66	2.40	—	16.91	5.73
22-02-74	29.0	32.59	5.38	8.±0	2.67	27.51	16.99	10.65	17.48
21-03-74	30.0	32.95	4.49	8.60	1.84	37.56	4.74	4.66	169.54
24-05-74	29.5	35.41	4.59	8.20	2.04	10.87	5.73	7.85	—
5-06-74	29.0	34.70	4.14	8.40	4.18	5.99	2.50	16.87	5.50
18-07-74	27.2	17.09	5.02	8.10	4.50	52.20	33.37	3.12	39.00
16-8-74	26.5	17.48	4.78	7.80	2.25	40.05	13.07	12.03	60.00
6-09-74	27.5	34.02	4.09	8.10	3.00	16.81	5.05	7.03	18.20
14-10-74	27.0	17.35	4.87	7.80	9.40	16.95	5.37	50.69	59.96
11-11-74	28.0	28.28	4.70	8.10	1.89	26.55	15.05	10.45	149.92
13-12-74	27.0	33.95	5.05	8.00	2.82	46.31	14.84	6.80	15.92
9-01-75	27.0	33.37	4.82	8.20	0.88	—	10.00	3.96	—

conditions do not exceed $5 \mu\text{g-at/l}$. The nitrite and nitrate values were also high and ranged between $2.50 \mu\text{g-at/l}$ to $42.79 \mu\text{g-at/l}$ and $2.40 \mu\text{g-at/l}$ to $271 \mu\text{g-at/l}$ respectively. The normal values of these two nutrients are about $1.0 \mu\text{g-at/l}$ $\text{NO}_2\text{-N}$ and $2.0 \mu\text{g-at/l}$ $\text{NO}_3\text{-N}$. The high values obtained for nitrogenous compounds is mainly due to ammonia, the main constituent of the effluents, which later gets oxidised to nitrite and then to nitrate by autotrophic bacteria. Few water samples from the same region, analysed for urea were found to contain very high concentrations ranging between 10.0 to $120 \mu\text{g-at/l}$ (Verlenkar, 1976). These values were considerably higher than the normal values found in the sea (Newell, 1967; Mc. Carthy, 1970;) Although urea is not known to effect the aquatic life directly, it may be responsible for increasing the ammonia concentrations by slow hydrolysis.

Arsenic: Arsenic was being used in the form of arsenic trioxide by Zuari Agro Chemicals Ltd. in the Vetrocoke process of urea production commercially. This being a cumulative poison may prove hazardous to human health if the consumption of contaminated sea food continues for a long time. At both the locations A and B, arsenic values were very high ranging between $3.00 \mu\text{g/l}$ to $583.20 \mu\text{g/l}$ as compared to the other inshore areas where the range was in between $1 \mu\text{g/l}$ to $43 \mu\text{g/l}$ (Fondekar

and Reddy, 1974). Arsenic exists in two inorganic forms as arsenite and arsenate, of which the arsenite is more toxic (60 times) than arsenate (Webb, 1966). In the Velsao Bay, arsenate was very dominant as compared to arsenite. Fondekar and Reddy (1975) have earlier reported the arsenate to be a dominant form (50 to 100% of the total) in the coastal waters of Goa.

These findings clearly indicate a definite increase in the concentrations of phosphorous, nitrogen and arsenic in the Velsao Bay. There also seems to be of accumulation of these substances in the region. This may have far reaching effects especially due to the increase in the concentration of arsenic. Continued eutrophication of the region due to excess of phosphorous and nitrogen compounds is another factor to be considered. This may result at times in low oxygen concentrations in the vicinity causing asphyxiation of fishes and other marine organisms. Fortunately, in future arsenic contamination may not be a problem in the vicinity, as the fertilizer factory has switched on to Benfield process which does not involve the use of arsenic trioxide.

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