



Distribution of Nutrients in the Coastal Waters of the Bay of Bengal

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ABSTRACT

The distributions of nutrients (ammonium, nitrite, nitrate, phosphate and silicate) were studied during 14th to 18th February 2013 in the coastal waters of the Bay of Bengal. Marked variations observed with respect to almost all nutrients determined. The detectable ranges of ammonium, nitrite, nitrate, phosphate and silicate were 0.026-23.52, 0.018-0.41, 0.026-4.46, 0.18-7 and 0.37-20.31 μ M respectively. The higher concentrations of nutrients were observed on 15th February 2013. Among these five nutrient species studied, silicate showed more pronounced variability. Surface and bottom differences were high with respect to nutrients concentration. Increased mixing water caused by increased wind and wave reaction causes the variation in concentration of nutrients was observed in this study area.

Keywords: Ammonium, Nitrite, Nitrate, Phosphate, Silicate.

INTRODUCTION

The nutrients found in seawater are essential to the survival of plant and marine life. Nutrient is functionally involved in the biochemical processes of living organisms. Traditionally, in chemical oceanography the term has been applied almost exclusively to silicate, phosphate and inorganic nitrogen. The role of nutrients in the ocean is to support the ocean food chains. Phytoplankton are primary food producers in the sea and through photosynthesis, they produce food for zooplanktons which are then consumed by organisms higher up in the food chain. Generally, nutrient is also present in sea water in very small amounts, but only minute quantities of these are required by living organisms. Nutrient is essential for phytoplankton growth as it is taken up by phytoplankton cells and built in as atoms in amino acids, proteins, nucleic acids, fats, etc. Among the nutrient elements, silicate is essential for diatoms to build up their skeletons which consist of biogenic silicate [1]. When phytoplankton, zooplankton or higher organisms die, these are decomposed by marine bacteria. This in turn takes a particle form of nutrient and in a dissolved form so that phytoplankton can use it more easily. Distribution of nutrients is useful or predicting the phytoplankton abundance and assemblages. Moreover, it could also be used as indicator of the status of nutrient loading or to predict productivity [2]. Nitrogen, phosphorus, silicon cycles play very important role in the marine environment. The nitrogen cycle controls the availability of nitrogenous nutrients and biological productivity in marine systems [3] and thus is linked to the fixation of atmospheric

carbon dioxide and export of carbon from the ocean's surface [4]. Phosphorus cycle regulates the phosphorus availability can impact primary production rates in the ocean as well as species distribution and ecosystem structure. In some marine and estuarine environments, phosphate availability is considered the proximal macronutrient that limits primary production [5]. The silica cycle is liable to undergo significant further alteration as the climate changes resulting in drastic changes in coastal primary production and to coastal ecosystems [6]. The global biogeochemical silica cycle is of great interest because of its impact on global CO₂ concentrations through the combined processes of weathering of silicate minerals and transfer of CO₂ from the atmosphere to the lithosphere. With the importance of nutrients as mentioned above, this study aimed to measure the nutrient level and to illustrate the nutrients distribution in the Bay of Bengal.

MATERIALS AND METHODS

The study was carried out onboard Krishnamma, at one station in the coastal waters of the Bay of Bengal as shown in figure 1. The present study involves 4h interval sampling from 14th to 18th February 2013. Sea water samples were collected using a 5 L Niskin sampler at water column depth of 100m. Samples were collected at five depths (0, 5, 10, 15 and 25m). water samples for nutrients analysis were filtered through GF/F filter paper (25mm, Whatman) placed in acid cleaned polyethylene bottles and frozen at -20^oc. Nutrients analysis was performed using a UV-Visible spectrometer (2450 Shimadzu). The ammonium was determined by indophenol blue method [7]. The inorganic phosphate and silicate were determined by the Strickland and Parson [8], nitrite by the Bendschneider method [9] and nitrate by the Morris and Riley [10] as modified by Grasshoff [11]. Calibrations were done using CSK standard solutions for nitrate (0.0, 10.0 and 20.0 µg atm L⁻¹ dissolved in 30.5% NaCl), phosphate (0.0, 0.5, 1.0 and 2.0 µg atm L⁻¹ dissolved in 30.5% NaCl), and silicate (0.0, 5.0, and 50.0 µg atm L⁻¹ dissolved in 30.5% NaCl). Additional standard solutions were prepared using artificial seawater to supplement the concentration ranges. Ultrapure water (Milli-Q water) was used for preparations of all solutions to minimize contamination and all reagents used were of analytical grade.

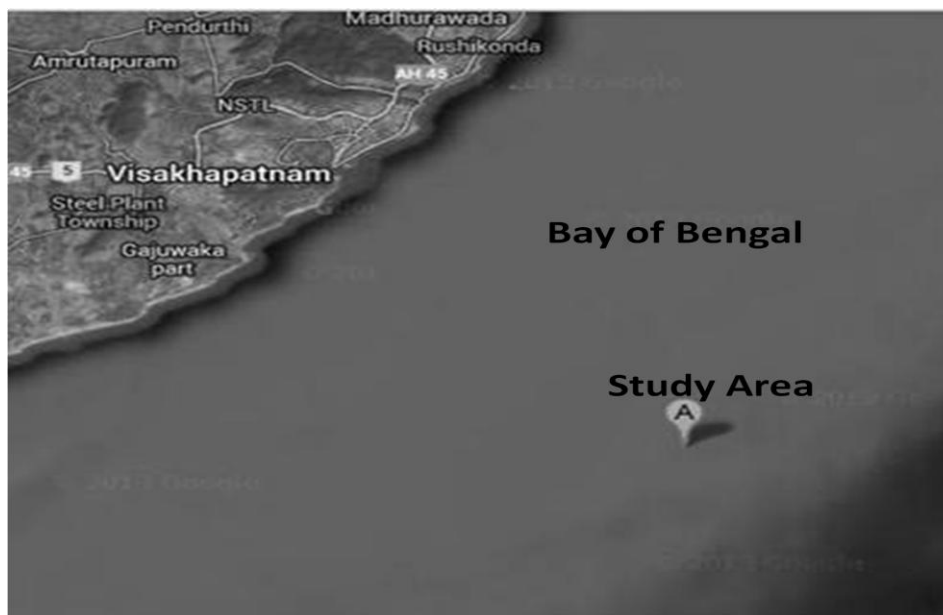


Fig. 1: Location of sampling station (17° 26' 56.04"N; 83° 31' 6.96"E)

RESULTS AND DISCUSSION

Ammonium: Large variation in the concentration of ammonium nitrogen with depth was observed in the study area as shown in table 1. The greater concentrations of ammonium nitrogen were observed on 15th February 2013, varied from 0.079 to 23.5 μ M as shown in fig. 2. The concentration was relatively low and slightly similar in the date of 16th February 2013 and 17th February 2013. Surface and bottom differences were high with respect to ammonium nitrogen concentration. The ammonium nitrogen in the lower reaches was minimum (0.0264 μ M) on 17th February 2013 and maximum (23.52 μ M) on 15th February 2013 (Fig. 2).

Table 1 Variations of nutrients concentration (μ M).

Date	Depth (meters)	Parameters				
		Ammonium	Nitrite	Nitrate	Phosphate	Silicate
14-2-2013	0	0.026-14.46	0.018-0.11	0.026-4.46	0.18-1.27	0.80-20.31
15-2-2013	5	0.052-22.59	0.037-0.11	0.026-0.61	0.18-7.00	0.37-10.45
16-2-2013	10	0.026-0.23	0.037-0.28	0.053-0.34	0.18-1.17	0.64-13.02
17-2-2013	15	0.026-22.51	0.018-0.22	0.053-0.45	0.22-1.17	0.85-5.96
18-2-2013	25	0.026-23.52	0.037-0.41	0.053-0.56	0.22-1.17	0.37-16.77

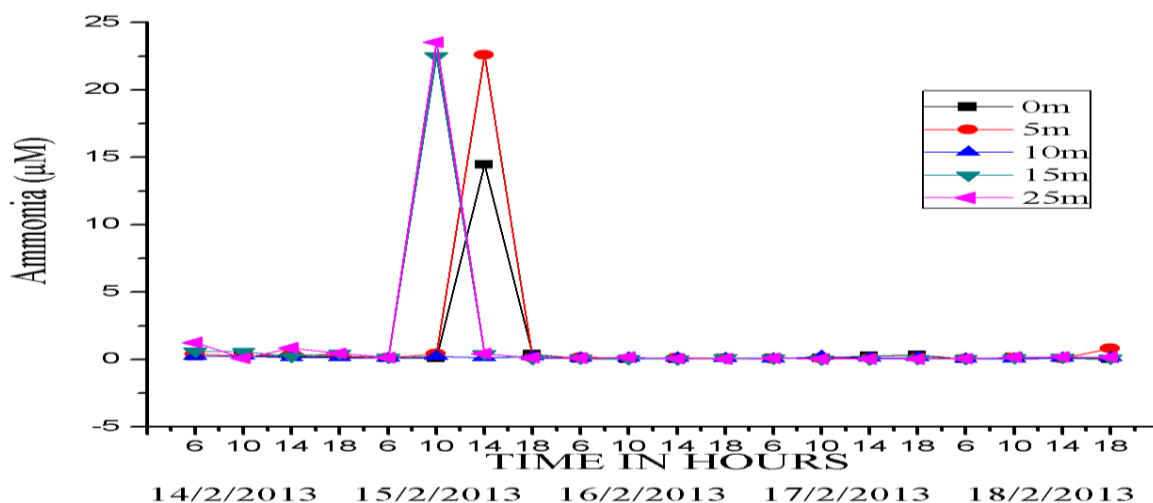


Fig. 2 Time-series variations in ammonium (μ M)

Nitrite: In the proposed study area nitrite concentrations varied from 0.018 to 0.41 μ M. The nitrite in the lower reaches shows minimum (0.018 μ M) on 16th February 2013 and maximum (0.41 μ M) on 15th February 2013 as shown in fig. 3. Low values of nitrite were observed at 6.00 in all the days. Surface nitrite concentrations were observed very low in this region. In contrast to nitrate and ammonium the nitrite concentrations were observed low in the study area as shown in Table 1. Highest concentration of nitrite (0.41 μ M) in the bottom waters at 18.00 was noticed on 15th February 2013 (Fig. 3).

Nitrate: The nitrate in the upper reaches shows minimum (0.026 μ M) on 16th February 2013 and maximum (4.46 μ M) on 15th February 2013 as shown in fig. 4. Subsurface levels showed lower nitrate concentration than those at the bottom and surface levels. The nitrate in the lower reaches shows minimum (0.26 μ M) on 14th February 2013 and maximum (0.77 μ M) on 17th February 2013.

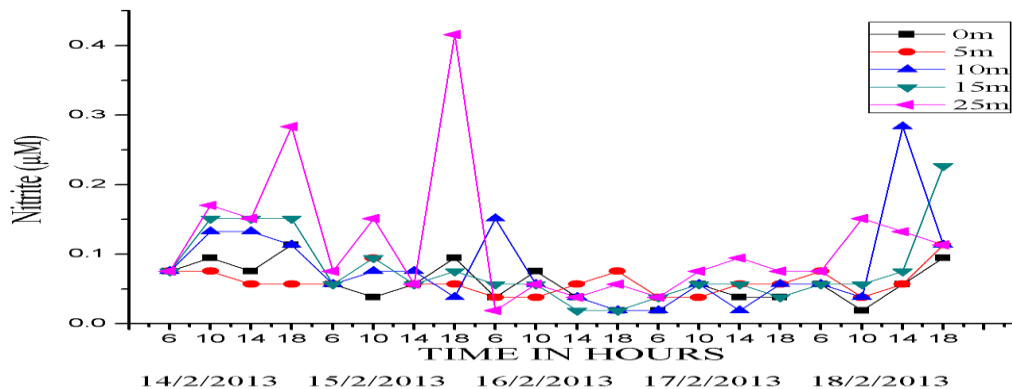


Fig. 3 Time-series variations in nitrite (μM)

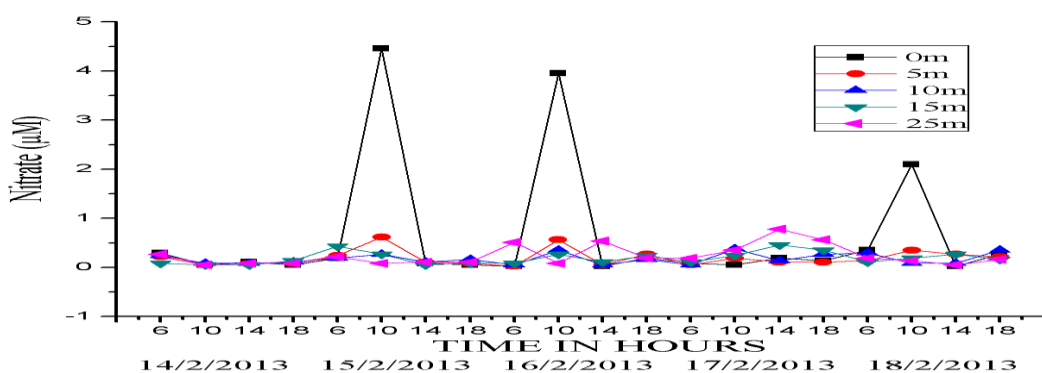


Fig. 4 Time-series variations in nitrate (μM)

Phosphate: As per the phosphate concentration interface waters showed high values. Throughout the period of observation minimum values were recorded on 17th February 2013. In the proposed study area phosphate concentrations varied from 0.18 to 7.00 μM (Table 1). Highest concentration of phosphate (7.00 μM) in the interface waters at 18.00 was noticed on 16th February 2013. In contrast to silicate and nitrate the phosphate levels were observed to be low in the bottom layer (Fig. 5).

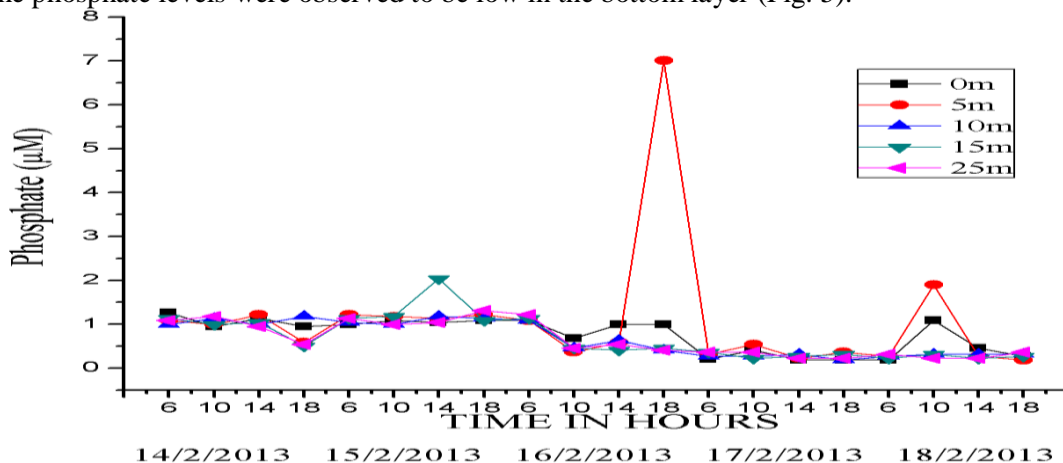


Fig. 5 Time-series variations in phosphate (μM)

Silicate: The concentration of silicate in the study zone varied from 0.37 to 20.31 μM (Table 1). Among the five nutrient species studied, silicate showed more pronounced variability than other ammonium, nitrate, nitrite and phosphate. Lower values of silicate concentrations were recorded on 15th February 2013. Silicate in the upper reaches was minimum (0.37 μM) on 16th February 2013 maximum on (20.31 μM) on 17th February 2013 (Fig. 6). In lower reaches it varied from 0.37 μM to 16.77 μM . Minimum was recorded on 14th February 2013 and maximum was recorded on 17th February 2013. Highest concentration of silicate (20.31 μM) in the surface waters at 10.00 was noticed on 17th February 2013 (Fig. 6).

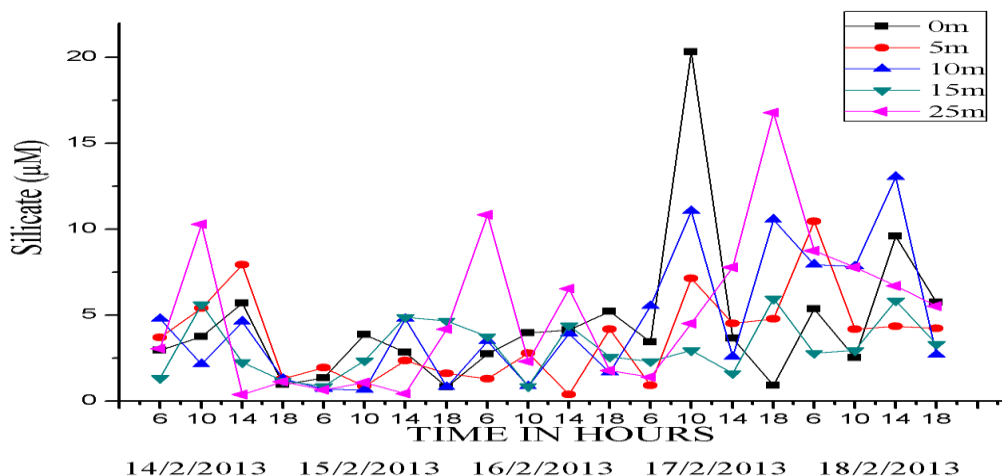


Fig. 6 Time-series variations in silicate (μM)

In general, the large variations in concentrations of nutrients were observed in the study area (Table 1). In the present investigation ammonium was found to be high (Fig. 2), this may partly be due to the death and subsequent decomposition of phytoplankton and also might be the excretion of ammonia by phytoplankton organisms [12]. Nitrite content was also found to be higher (Fig. 3) this could be attributed to the variation in phytoplankton, excretion and oxidation of ammonia [13]. Surface levels showed high concentrations of nitrate (Fig. 4) may be due to the nitrification process. The low concentrations of nitrite and nitrate may be due to the denitrification process [14]. In the bottom waters nutrient concentrations were generally enriched may be due to benthic demineralization of organic matter [15]. In the study area the lower concentration of dissolved inorganic nitrogen (ammonium+nitrite+nitrate) and phosphate may be due to the phytoplankton assimilation in the surface waters followed by aerobic decomposition of the sinking organic matter, which recycles nitrogen and phosphorus back into dissolved forms in deeper water [16]. The sources and sinks of phosphate may be due to the sediments in sea water and higher biological activity [17]. Photosynthesis also plays an important role in the phosphate levels in sea water. The low concentrations of silicate (Fig. 6) observed may be due to the planktonic diatoms population [18-20]. The dissolved silicate content of the study area comparatively higher than nitrate and phosphate (Table 1). This may be due to the effect of runoff from land, upwelling and blooming of phytoplankton. High biological productivity with high suspended sediments loads might be responsible for the removal of dissolved silicon from sea water [21-22]. Source of nutrients is normally associated with the increase in salinity and decrease in temperature [23].

APPLICATIONS

The analysis of nutrient contents in any coastal water determine its potential fertility, and therefore, it is important to gather information about their distribution and behavior in different coastal ecosystems. Although, the life supporting processes in marine coastal ecosystems require many inorganic substances like, nitrogen, phosphorous, and silicon are considered to be more important than others, as they play a key

role in phytoplankton abundance, growth and metabolism. Therefore studies pertaining to the source of origin distribution pattern and rate of utilization of these inorganic components have become an imperative scientific research in coastal areas.

CONCLUSIONS

The results of the study showed that the distribution of the nutrients viz., ammonium, nitrite, nitrate, phosphate and silicate concentrations varied with depth. Among these five nutrients species studied, silicate showed more pronounced variability. Surface and bottom differences were high with respect to nutrients concentration. The distribution of nutrient studies will certainly provide better scientific basis to understand the ecosystem of coastal waters of the Bay of Bengal.

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