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Original Research Paper

Distribution of Nutrients and Chlorophyll-*a* in Mangrove Environment of Red Sea Coast of Yemen

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ABSTRACT

The present study is aimed at screening for the concentration of nutrients and chlorophyll-*a* in mangrove environment of Red Sea coast of Yemen. N-NO_2 concentration ranged from 0.50 µg/L at Kamaran Island to 2.20 µg/L at Al-Zubayr with mean of 1.483 µg/L. N-NO_3 concentration ranged from 0.70 µg/L at Kamran Island to 3.10 µg/L at Dhubab with mean of 1.917 µg/L. N-NH_4 concentration ranged from 0.30 µg/L at Al-Zubayr to 1.00 µg/L at Dhubab with mean of 0.608 µg/L. P-PO_4 concentration ranged from 2.50 µg/L at Al-Zubayr to 6.10 µg/L at Al-Hodiedah with mean of 4.333 µg/L. Si-SiO_2 concentration ranged from 15.30 µg/L at Al-Zubayr to 23.40 µg/L at Al-Hodiedah with mean of 18.833 µg/L. Chlorophyll-*a* concentration ranged from 0.200 µg/L at Al-Zubayr to 0.320 µg/L at Al-Hodiedah with mean of 0.263 µg/L. The maximum concentration of nutrients , found at the levels of minimum oxygen and relatively high ammonia concentration, is usually attributed to recycling of nutrients by phytoplanktonic and bacterial activities. The high concentration of phosphate may be attributed to the freshwater inflows as a result of heavy rains in the highlands. The high concentration of silicate may be attributed to severe sandstorms affecting the coastal areas. The concentration of chlorophyll-*a* may be attributed to the water mass that contains nutrients as well as phytoplankton.

INTRODUCTION

Mangroves are salt-tolerant trees usually found in association with mudflats. Globally, mangrove ecosystems contain more than 60 species of trees and provide living space for more than 2000 species of fish, invertebrates and epiphytic plants (Whitfield 1979).

There are two types of mangroves in Yemen (*Avicennia marina* and *Rhizophora macronata*). Yemen's mangrove communities include faunal assemblages of fish, crab, shrimp shells, clams, birds and green turtles, and it is important to productive organic carbon.

Analysis of pollutants in sediments has become an important tool for tracing anthropogenic pollution of water (Senten 1989), because some pollutants are adsorbed by material in suspension and by fine-grained particles. After flocculation and sedimentation they are enriched in bottom deposits by a factor of 1000 or more (Forstner 1979).

Nutrients are necessary for the growth and productivity of phytoplankton. Nutrients concentration throughout the water column in the southern Red Sea is higher than that in the central and northern region (Weikert 1987). Generally, water of the Red Sea is very poor in nutrients , especially in the open waters compared to the Gulf of Aden (Poisson et al. 1984, AbuBakr et al. 2007).

The objectives of the proposed study are to: 1-Investigate the status of nutrients and chlorophyll-*a* residual in mangrove environment of Red Sea coast of Yemen, including identifying their potential sources in this region. 2-Results obtained during the study will serve as a baseline data for further follow-up study in the environment of mangrove Red Sea Coast of Yemen.

DESCRIPTION OF THE REGION

The Red Sea bibliographic information was extensively cited in Barrat (1987), Senten (1989) and EPC (2001). Moreover, most of the recent information on the Yemen Red Sea coastal environment, flora and fauna was detailed or quoted in IUCN (1987) and Khalaf et al. (2006). The Red Sea is a long narrow basin separating Africa from Asia, and extending from NNW to SSE between latitudes of 30°N to 12°30'N almost in a straight line. Its total length is 1932 km and average breadth is 280 km. The maximum breadth is only 306 km in the southern sector near Massawa. It attains its minimum breadth of 26 km at the southern end in the Straits of Bab el-Mandab. The area of the Red Sea is 4.6×10^5 km^2 and mean depth is about 500 m. The maximum recorded depth is 3039 m in the axial trough at 19°35'N, 38°40' E. The real separation of the Red Sea from the Gulf of Aden lies at the north of Bab el Mandab near the Great Hanish Island.

MATERIALS AND METHODS

The samples were collected at six stations shown in (Table 1, Fig. 1). The station locations were identified by Global

Positioning System (GPS) (Table 1). The sampling programme was initiated during 1-7 November 2010. At each occasion mangrove water sample collection was obtained from the surface water by a polypropylene reversible Van Dorm water sampler. After collection, the seawater was filtered through Whatman GF/C millipore bottles. Water samples were kept in ice in a field box till return to the laboratory where they were placed in a deep freeze (about -20 C°). The samples were analysed for nitrite, nitrate, phosphate, silicate, ammonia and chlorophyll-*a* according to the standard chemical methods for marine environmental monitoring (UNEP 1988) and (Weilder 1974).

All the chemicals used in the study were of high purity analytical grade. Double distilled and/or deionized water was used for preparing the standards and dilution of samples.

Table 1: The sampling locations of the study.

Nearest City	Sampling Locations (Location)	Station Number
Kamaran Island	E 43°20'150" ; N 15°41'0.70"	I
Al-Zubayr	E 43°56'115" ; N 15°55'979"	II
Al-Urg	E 42°52'282" ; N 15°0.5'73"	III
Ras-Kathib	E 42°57'0.15" ; N 14°52'115"	IV
Al-Hodiedah	E 43°14'139" ; N 13°50'247"	V
Dhubab	E 43°40'130" ; N 13°12'145"	VI

Blank determinations were also carried out for each group of samples.

Spectrophotometer (Model Supertonic 501) was used to measure absorbance at the recommended wavelength.

Nitrite: Nitrite determination in the sampled sediment was

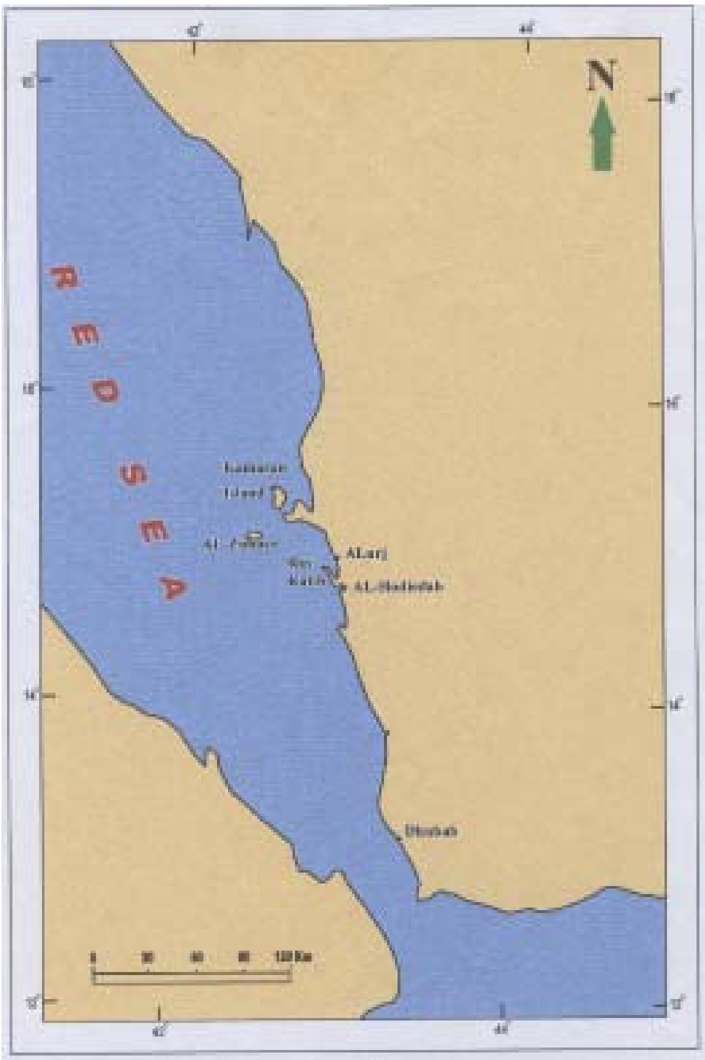

Fig. 1: Map of sampling locations.

Table 2: Results of the water analysis. Values are in µg/L.

Station Number	Nearest City	Nitrite $N\text{-}NO_2$	Nitrate $N\text{-}NO_3$	Ammonia $N\text{-}NH_4$	Phosphate $P\text{-}PO_4$	Silicate $Si\text{-}SiO_2$	Chlorophyll-*a*
I	Kamaran Island	0.50	0.70	0.60	3.40	17.20	0.210
II	Al-Zubayr	2.20	2.50	0.30	2.50	15.30	0.200
III	Al-urg	1.90	2.30	0.40	4.60	18.50	0.280
IV	Ras- Katib	0.90	1.40	0.60	5.20	20.60	0.300
V	Al-Hodiedah	1.30	1.50	0.75	6.10	23.40	0.320
VI	Dhubab	2.10	3.10	1.00	4.20	18.00	0.270
Range		0.050-2.20	0.70-3.10	0.30-1.00	2.50-6.10	15.30-23.40	0.200-0.320
Mean		1.483	1.917	0.608	4.333	18.833	0.263

carried out according to Grasshoff (1983).

Nitrate: The method employed in the present study was based upon the reduction of nitrate to nitrite by allowing the water sediment to pass through a column packed with copper-coated cadmium. The latter was determined colorimetrically via the formation of an azo dye (Grasshoff 1983).

Ammonia: Ammonia measurement was carried out according to the method described by Strickland & Parsons (1972).

Reactive phosphate: The determination of dissolved inorganic phosphate in water samples was carried out according the method described by Murphy & Riley (1962). This method is based on the formation of a highly coloured blue phospho-molybdate complex. The modification brought by Koroleff (1983) was also taken into account.

Reactive silicate: Determination of reactive silicate in the samples was carried out according to the method described by Koroleff (1983).

Chlorophyll-*a*: The determination of chlorophyll-*a* was carried out according to the method described by Weider (1974).

RESULTS AND DISCUSSION

The results of the study are depicted in Table 2 and Fig. 2. $N\text{-}NO_2$ concentration ranged from 0.50 µg/L at Kamaran Island to 2.20 µg/L at Al-Zubayr with mean of 1.483 µg/L. $N\text{-}NO_3$ concentration ranged from 0.70 µg/L at Kamran Island to 3.10 µg/L at Dhubab with mean of 1.917 µg/L. $N\text{-}NH_4$ concentration ranged from 0.30 µg/L at Al-Zubayr to 1.00 µg/L at Dhubab with mean of 0.608 µg/L. $P\text{-}PO_4$ concentration ranged from 2.50 µg/L at Al-Zubayr to 6.10 µg/L

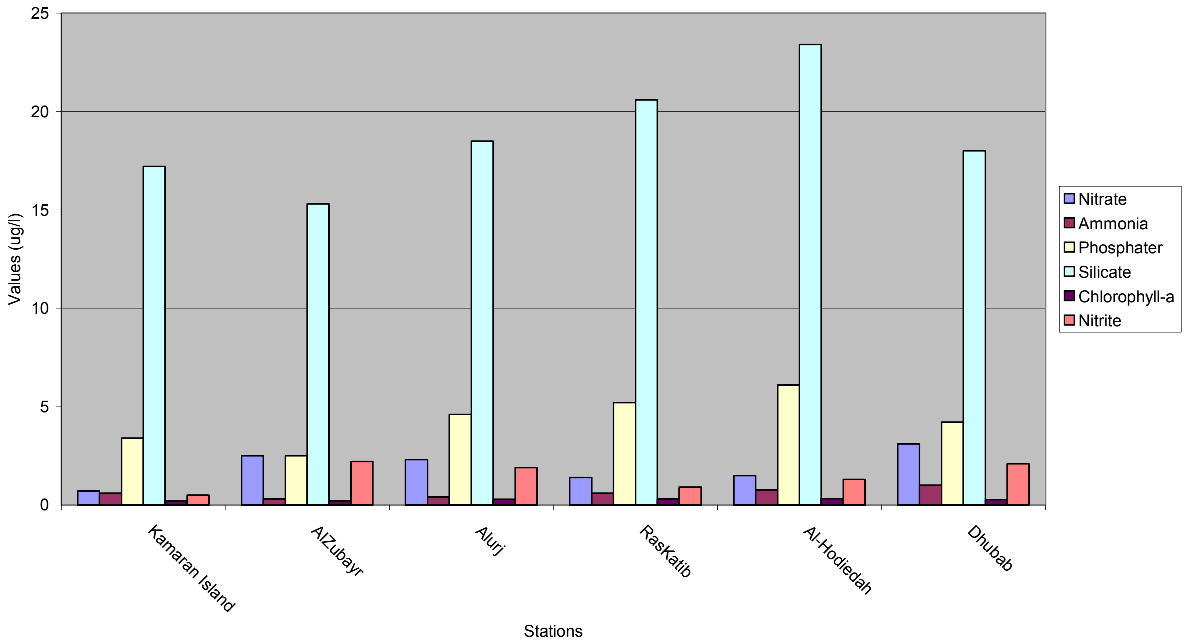

Fig. 2: Distribution of nutrient salts and chlorophyll-*a* in mangrove environment of Red Sea Coast of Yemen.

at Al-Hodiedah with mean of 4.333 µg/L. Si-SiO_2 concentration ranged from 15.30 µg/L at Al-Zubayr to 23.40 µg/L at Al-Hodiedah with mean of 18.833 µg/L. Chlorophyll-*a* concentration ranged from 0.200 µg/L at Al-Zubayr to 0.320 µg/L at Al-Hodiedah with mean 0.263 of µg/L. The maximum concentration of nutrients , found at the levels of minimum oxygen and relatively high ammonia concentration, can be attributed to recycling of nutrients by phytoplanktonic and bacterial activities (IUCN 1987), and may be attributed to the freshwater inflows as a result of heavy rains in the highlands. The high concentration of silicate may be attributed to the severe sandstorms affecting the coastal areas. The concentration of chlorophyll-*a* may be attributed to the water mass that contains nutrients as well as phytoplankton (GEF 1999).

CONCLUSIONS

Mangrove environment of Red Sea coast of Yemen contains relatively higher concentration of nutrients than the open waters, and is also more productive than the open waters. The variation between locations may, among others, be due to water mass exchange with the Gulf of Aden, and primary productivity.

RECOMMENDATIONS

- Preserving the mangrove habitats in the Red Sea in view of their great significance.
- Seeking to the increase of concentration of nutrients, chlorophyll-*a* that is necessary for the growth of fishery stock and marine food security.

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