Spatial and Seasonal Variations of Physicochemical Parameters Associated with Acidification of Nayband Mangrove Ecosystem (Bushehr Province, Iran)

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***Abstract*—** Since the Industrial Revolution, increasing CO_2 levels of the atmosphere and other greenhouse gases has led to international efforts to control its release and reduce its environmental impact. CO2 is absorbed through photosynthesis by terrestrial and aquatic plants from the atmosphere. The most important way to remove CO_2 in dry areas is by aquatic plants. In the Middle East, the main sink of CO2 is the Persian Gulf, which leads to the acidification of its marine environment. In this paper, the parameters associated with acidification of Nayband mangrove ecosystem, including total alkalinity, pH, salinity, water temperature, electrical conductivity and dissolved oxygen were measured. Samples were collected from five stations distributed throughout the mangrove during two seasons of summer (September 2016) and winter (February 2017). The results showed that the average of alkalinity, salinity, electrical conductivity and temperature at different stations in summer was significantly higher than in winter ($p<0.05$) and the mean pH in winter was significantly higher than in summer ($p<0.05$).

***Keywords*—** Acidification, Boushehr, Mangrove, Nayband.

I. Introduction

MANGROVE ecosystems are found in tropical and subtropical regions which provide suitable shelter for both marine and terrestrial organisms [1]. Mangroves protect coastal areas from erosion, storm surge (especially during hurricanes and tsunamis) [2]. The mangroves' massive root systems are efficient at dissipating wave energy [3] Likewise, mangroves slow down tidal water to levels that are enough for sediments to be deposited as the tide comes in, leaving all except fine particles when the tide ebbs [4]. In this way, mangroves build their own environment. The healthy aquatic ecosystem depends on the physico-chemical and biological characteristics [5]. Therefore, several studies have been conducted to evaluate the health status of mangroves ecosystems by measuring physicochemical parameters [6]-[10].

The Nayband, the largest mangrove forest located in the Bushehr province in south of Iran, is largely affected by oil and gas activities and their pollution (Pars Special Economic Energy Zone), land reclamation, agricultural and aquaculture activity, over using natural resources, and changing landuse. Road construction has been led to hydrological changes and subsequent decline of mangrove forests of east Nayband Bay. Therefore, in order to assess the environmental health of these ecosystems, and identifying the negative factors affecting the health of these forests, as well as providing solutions for reducing pollution in these environments or improving the condition of these ecosystems, we investigated the Nayband mangrove ecosystem. To achieve these goals, physicochemical parameters such as temperature, salinity, electrical conductivity, dissolved oxygen, pH, and total alkalinity were investigated.

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II. Material and Methods

A. Study Area

The Mangrove forests of Nayband, are the widest mangrove communities in above 27 degrees latitude in the northern coast of the Persian Gulf, and the last dense and extensive complex of these ecosystems in the north-west Indian Ocean and has an area of about 390 hectares. Water samples were collected from 5 stations distributed throughout the mangrove forest (Figure 1). Sampling was carried out during summer (September 2016) and winter (February 2017) seasons. From each station three replicate samples were taken.

Fig. 1 Sampling stations

B. Analytical Method

Total alkalinity was measured by open-cell potentiometric titration [11]. Dissolved oxygen and pH was measured in situ

using Hack multi meter (HQ40d). Conductivity and salinity were measured in situ using a WTW 3210 portable meter.

C. Statistical Analysis

For Statistical analysis, the SPSS software version 22 was used. To obtain the distribution of data the Klomogrov-Smirnov test was used. The statistical differences were determined by Mann-Whitney U test. Spearman test was used to determine the correlation between the parameters.

III. Result and Discussions

Fig. 2 shows the measured total alkalinity of surface water in two seasons at different stations. The results showed that the average of alkalinity at all stations in summer was significantly higher than in winter ($p<0.05$). The increase in alkalinity during the summer seasons may be due to industrial discharges, as well as low rainfall, high evaporation, sea water intrusion [12]. Total alkalinity showed significant negative correlation with pH at respective stations in two seasons. In summer, total alkalinity was shown significant negative correlation with temperature at respective stations. In winter, total alkalinity was shown significant positive correlation with salinity and conductivity. In the oceans total alkalinity changes first of all with salinity as do the concentrations of Na^+, Cl^- etc. Further important changes are due to various biogeochemical processes such as calcium carbonate precipitation or production of particulate organic matter by microalgae [13].

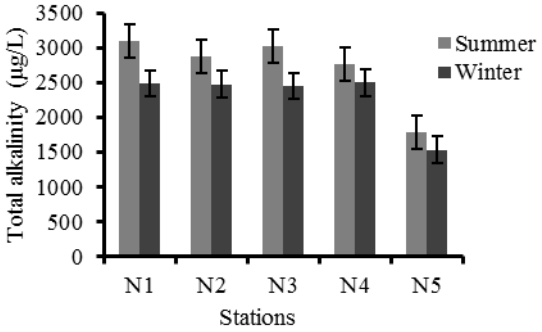

Fig. 2 Mean (± SE) seasonal total alkalinity of surface water samples at each station

Fig. 3 represents the measured pH of surface water in two seasons at different stations. The average pH at all stations in winter was significantly higher than in summer ($p<0.05$). The average pH varied from 7.0 to 8.5 at different stations in summer and winter, respectively. Generally fluctuations in pH values during different seasons of the year is attributed to factors like removal of CO_2 in photosynthesis, through bicarbonate degradation, dilution of seawater by freshwater influx, reduction of salinity, temperature and decomposition of organic matter [14], [15].

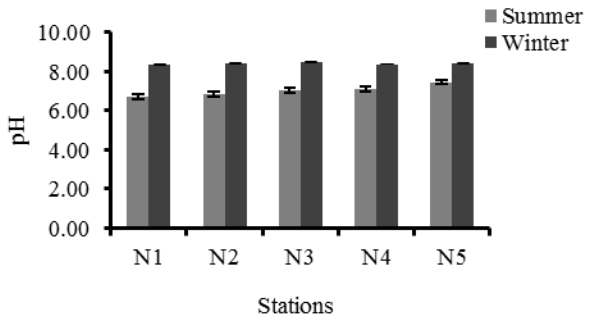

Fig. 3 Mean (± SE) seasonal pH of surface water samples at each station

Figure 4 shows the measured salinity of surface water in two seasons at different stations. The average salinity in summer was significantly higher than in winter ($p<0.05$). Lagoons and creeks are diluted considerably by freshwater from rain and river systems in the wet season, while in the dry season; evaporation becomes more prominent [16], [17].

Electrical conductivity displayed significant seasonal variation ($P<0.05$) and comparatively lower values were detected during winter. Electrical conductivity is extremely sensitive to temperature and increases at higher temperatures.

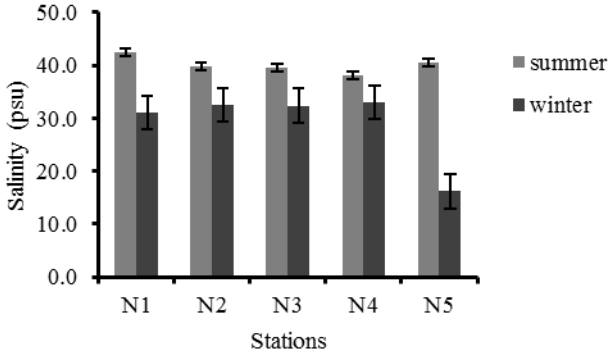

Fig. 4 Mean (± SE) seasonal salinity of surface water samples at each station

Figure 5 shows the measured dissolved oxygen (DO) of surface water in two seasons at different stations. The statistical analysis shows that the mean DO in winter is significantly higher than in summer ($p<0.05$) at stations 2, 3 and 4. This is due to the fact that in winter, the water temperature is lower than in summer, resulting in higher concentrations of DO. But, the mean DO in summer is significantly higher than in winter ($p<0.05$) at station 5. In aquatic systems, oxygenation is the result of an imbalance between the process of photosynthesis, degradation of organic matter, re-aeration [18], and physicochemical properties of water [19].

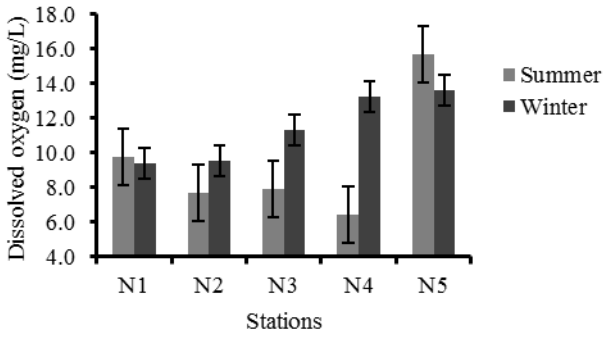

Fig. 5 Mean (± SE) seasonal dissolved oxygen of surface water samples at each station

IV. CONCLUSIONS

In this paper, the parameters related to acidification of Nayband mangrove ecosystem as the largest mangrove in Bushehr province have been investigated. The study revealed that the physicochemical parameters like water temperature, pH, electrical conductivity, salinity, dissolved oxygen and alkalinity exhibited considerable seasonal and spatial variations. There are some difficulties to assess overall acidification status of Nayband mangrove ecosystem due to variations in analytical procedures between studies and the presence of an unknown background in this ecosystem. But, In comparison to other studies [12], [20] on mangrove ecosystem in other part of the world, it could be concluded that this ecosystem is in a good state of health for acidification.

Considering the need for long-term data to study the acidification process of an ecosystem, it is suggested that annual and seasonal monitoring be carried out. The findings of this research can be useful as a basis for future research.

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