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REGULAR ARTICLE

ASSESSMENT OF THE pH OF WATER AND SEDIMENTS AT RAMSAR SITES IN GABES CITY, TUNISIA

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ABSTRACT

Very few studies of the potential of Hydrogen (pH) of water and sediment wetland at Ramsar site 2076/2012 have been reported in the literature. In this context, a sampling was collected from five sites of Oued El Malah and Tarf El Maa (north of Gabes: south-east of Tunisia). The results showed that the pH complies with national and international regulations (6.5 ≤pH ≤ 8.5). Indeed, the hydrogen potential of water was varied between 7.88 (S2) and 8.24 (S1). It is ranged from 7.76 (S1 and S2) to 8.05 (S4) for sediments. Positive correlation (r = 0.985) and highly significant difference ($P<0.01$) were recorded for water and sediment pH. To confirm or refute this hypothesis, additional studies (physicochemical, biochemical and bacteriological analysis) are needed to assess the quality of these areas.

Keywords: Potential of Hydrogen, Sediments, Water, Wetland

INTRODUCTION

Recently, increasing attention by the scientific community has focused on the aquatic ecosystems preservation. Their continuous and increasing degradation with eutrophication phenomena is a reality to which few places in the world escape. The major changes by anthropogenic and natural factors have potential ecological consequences [1]. Water is an indispensable element for the lives of humans, animals and plants. Having water available in sufficient quantity and quality was contributed to the maintenance of health. Water can be also a disease source due to contamination by household, industrial, agricultural waste, excreta and various organic wastes [2]. Environmental impacts were intensified by industrial activities, urban development and agricultural practices industrialization [3,4]. Pollutant inputs (chemicals, fertilizers, urban discharges and wastewater) are damaging the environment and have a direct impact on human health and biological resources (birds of national and international interest) [5-8]. The water use for food and hygiene purposes requires an excellent physicochemical and microbiological quality. Various studies were assessed the water quality importance (potability, irrigate ability, impact on human health and environment, etc.) [9]. Very few studies on the role of sediments in aquatic environments in Africa have been reported in the literature. However, the most of research have been carried out relate to the water column [10]. In those environments, the solid phase was played a decisive role in the ecosystems equilibrium. Indeed, water was influenced by the physical, chemical and biological characteristics of sediments [9].

In order to contribute the control of water and sediment quality of five sites in the Gabes governorate (South-East of Tunisia), we carried this investigation to assess the potential of Hydrogen (pH) of those sites. The pH gives an indication on the type of dominant biological activity, the overall availability of mineral elements and the general chemical conditions [11].

MATERIALS AND METHODS

Study area

The five sampling sites are located in the north of Gabes (South-East of Tunisia) (Fig.1). The climate is predominantly arid with a dry season. Table 1 shows the variation in monthly air temperature [12] and the soil in the sampling site are gypsiferous and saline [12, 13].

Sediments and water sampling methods

The sites are the number of five and were conducted in wetland areas (at the Ramsar Site 2076/2012) (fig. 2). The sites are located in the North of Gabes (table 2). Nine samples per replicate (3 replicates) for each water and sediment sampling were collected from each site. These samples were collected in sterile polythene bags (for sediment samples) and flasks (for water samples), and brought to the laboratory.

Wetland areas are transition zones between land and

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aquatic systems where the main factor influencing the biotope and its biocenosis is water [14].

Ramsar Site 2076/2012 is convention on Wetland areas of International Importance (water-bird habitats) and is an international treaty adopted on 21 September 2012 for the conservation and sustainable use of wetlands, aimed to halting their degradation or loss, today and tomorrow, recognizing their ecological functions as well as their economic, cultural, scientific and recreational value. [15].

Sediments and water analysis of potential of Hydrogen

The Chen and Ma [16] and Rodier [17] methods were used to determine the potential of Hydrogen of sediments and water, respectively.

Statistical analysis

The potential of Hydrogen of sediments and water were analyzed using the multinomial distribution and the cumulative logit as link function. These variables were compared by analysis of variance (ANOVA) and means of the values were separated with Duncan multiple range test at $P<0.05$. Statistical analyses were conducted using SPSS 20.0 software. The Principal Component Analysis (PCA) was used to assess the relationships between pH of sediments and pH of water and associates the correlated parameters into a smaller subset using XLSTAT-2017 software.

RESULTS AND DISCUSSION

The pH values of the water and sediment at the different sampling sites are shown in table 3. The variation of the potential of Hydrogen was showed a highly significant difference ($P<0.01$). A first exploratory analysis of the potential of Hydrogen is provided by the PCA (using XLSTAT-2017 software). The water pH was showed a positive and highly significant correlation with the sediment pH ($r = 0.985$). The first ($F1 = 50.27\%$) and the second ($F2 = 49.73\%$) principal components were explained 100% of the variances (Fig.3). According to the pH class, our samples are moderately alkaline [17, 18].

The water pH at the five sites (S1 to S5) was ranged between 8.24 and 7.88. The exception of site S2 (furthest of the beach), the pH values were increased to S1 (8.24), S5 (8.14), S3 (8.04) and S4 (8.01) (near of the beach). The standards setting by the local and international regulations for water quality was recommended that pH is between 6.5 and 8.5 [2]. Comparing the results obtained from study areas (table 3) to international standards, it appears that the pH is normal. The water pH is an important quality indication and provides important information on geochemical equilibrium or the calculation of the microelements solubility [19]. It depends on the water origin, the geological nature of the substrate and the watershed. This parameter was conditioned a large number of physico-chemical equilibria between water, dissolved carbon dioxide, carbonates and bicarbonates which constitute buffer solutions of conferring on aquatic life and bird-water a favorable development [20, 21].

The results of the pH analysis are shown in table 3, showing that the majority of the sediments have low to medium pH values. The sediments pH was ranged from 7.76 (S1 and S2) to 8.05 (S4) with a mean of 7.91. The pH is an important parameter of sediment dynamics. It is an abiotic key because their acidity or basicity degree playing an important role in the nutrients assimilation. It has an influence on three important components: nutrients bioavailability, biological activity and structural stability. The pH variation was depending of buffer potential variations, soil moisture status, seasonal variations, temperature and presence or not of crops [22]. The pH increasing causes the augmentation of the sites number (carboxyl groups of organic matter, hydroxides of oxides and clay minerals) [23, 24]. Humic compounds in sediments were moved from an aggregate configuration to a more stretched structure where complexing sites are more accessible [25, 26]. The pH elevation promotes the oxides, hydroxides or hydroxide carbonates precipitation [27-29]. The change in pH has an effect on the oxides crystallization degree and therefore on the adsorption capacity of the reducible phases [30, 31, 32]. However, the low pH the dissolution of the alumino-silicate compound decreases the effective surface area of adsorption [23, 27].

CONCLUSION

This study was focused on the evaluation of the potential of Hydrogen of water and sediments of the five sites at Ramsar Site in Gabes city (South-East Tunisia), based on this physical analysis. It appears that all the sediment and water samples were in the national and international regulations ($6.5 \le pH \le 8.5$). But, it would be desirable to conduct additional studies (physicochemical, biochemical and bacteriological analyzes) to confirm or refute this hypothesis.

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Table 1: Monthly air temperatures (minimum, maximum and average temperature) were obtained from regional meteorological stations (data of the year 2016)

Month	Minimum temperature	Maximum temperature	Mean temperature
January	8	17	12.5
February	9	18	13.5
March	11	22	16.5
April	14	24	19
May	18	28	23
June	22	32	27
July	24	34	29
August	25	35	30
September	23	32	27.5
October	19	28	23.5
November	13	23	18
December	9	18	13.5

Table 2: Location and description of the different sampling sites (S1 to S5) located in the Gabes city (southern Tunisia)

Sites	geographical location	Latitude	Longitude
S1	Oued El Malah (center)	34 °00'30.07 N	10 °01'57.16 E
S2	Oued El Malah (beginning)	34 °00'27.54 N	10 °01'45.62 E
S3	Beach	34 °00'31.50 N	10 °02'42.76 E
S4	Oued El Malah (end)	34 °00'27.69 N	10 °02'47.99 E
S5	Chott Taref El Maa	34 °04'55 N	10 °01'34.23 E

N= North, E=East.

Table 3: Potential of hydrogen variation of water and sediment samples from five sites

Sites	Potential of hydrogen (pH)	
	Water	Sediment
S1	8.24±0.02a[a]	7.76±0.005d
S2	7.88±0.02e	7.76±0.006d
S3	8.04±0.01c	7.97±0.01c
S4	8.01±0.01d	8.05±0.01a
S5	8.14±0.006b	8.01±0.01b
P-value [b]	**<0.01**	**<0.01**

[a]Probabilities associated with individual F tests, [b]Duncan's Multiple Range Test, values followed by different superscripts are significantly different at P≤0.05.

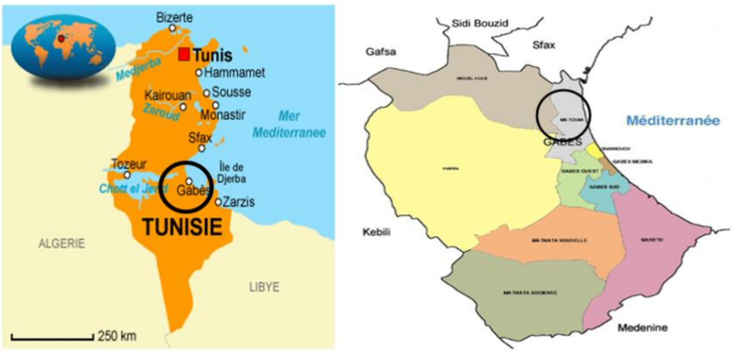

Fig. 1: Location of the study site of Chott Sidi Abdel Salam Oasis

Fig. 2: Location of sampling sites: Oued El Malah (S1, S2 and S4), beach (S3) and Chott Taref El Maa (S5)

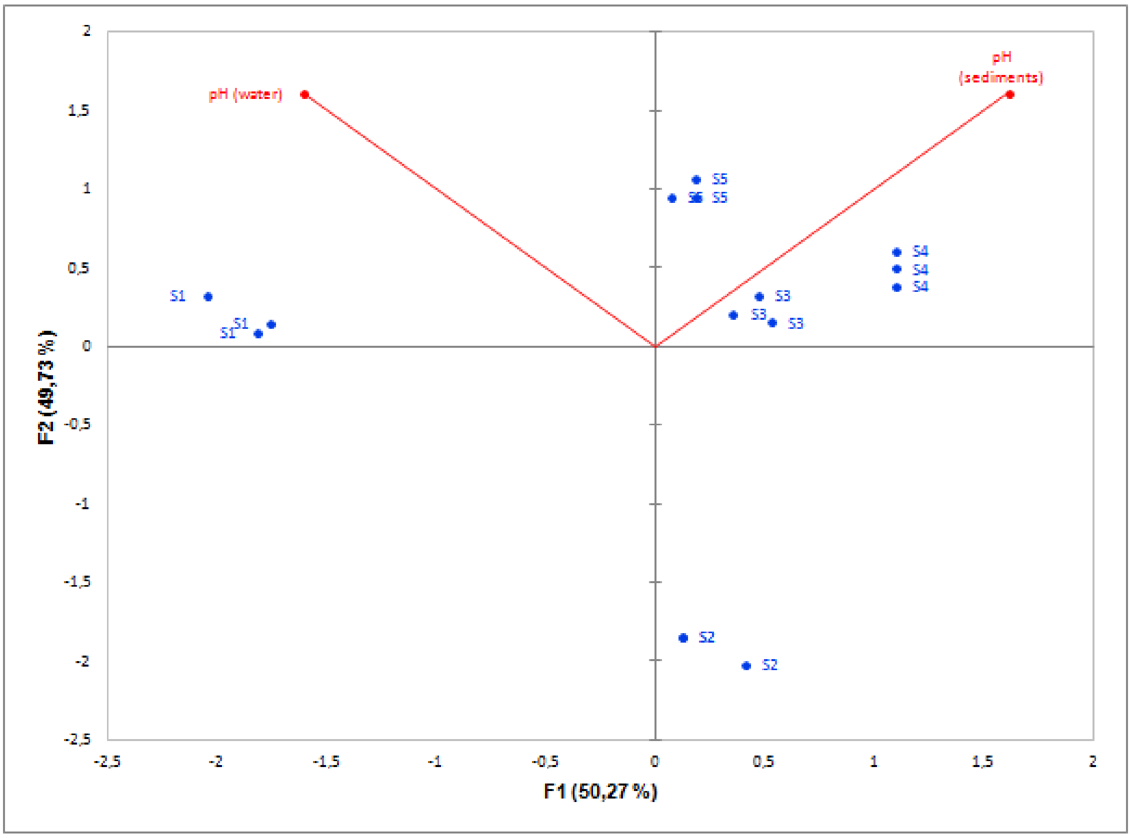

Fig. 3: Principle component analysis (PCA) plot of first two principal components, depicting relationship among sediment and water pH. The first (F1) and second (F2) principal components explain 100% of the variance

AUTHORS' CONTRIBUTIONS

1. Dr. Abdelhak Rhouma (Main author conducting the research)
2. Mr. Naoufel Hamouda (Supervisor)
3. Mr. Slaheddine Bessadok (Supervisor)

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