A study on hydrographic properties in the coastal waters along Hadhramout Coast of Yemen

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Abstract

Data were collected from five sites at Hadhramout, Yemen ,on seasonal basis from August 2013- May 2014; where the physical and chemical properties of seawater were measured. It was found that the physical and chemical properties of seawater have significant seasonal variations within the coast with values ranging from 7.9-8.8 , 24.3 ºC -31.4 ºC, 51.7- 52.8 ms/cm, 5.2 mg/l - 6.8 mg/l for water pH, temperature, electrical conductivity and dissolved oxygen, respectively. The higher concentration of PH and temperature during May was found at station 11, while Concentration of dissolved oxygen (DO) was relatively high during August at station10,12 and 14, and, salinity were at their minimum level during this period at station 4, 8 and 15. The results obtained reflect the effect of the warm tropical zone of the Gulf of Aden and the Arabian Sea, irregular topography, local hydrographic condition and the result of upwelling current.

Keywords: Coastal waters, physicochemical properties, Seasonal variations,Hadhramout coast of Yemen.

Introduction

The coastline of Yemen extends to well over 2500Km and borders of the Red Sea, the Gulf of Aden / Arabian Sea and Indian Ocean. Yemen also has a large number of islands in all its seas. The largest of which is Socotra Island , one of Socotra Archipelago in the Indian Ocean. The unique geographical location of the country at the southern end of the Arabian Peninsula forms also the connection bridge between two large continents (Asia & Africa). This location endowed Yemen with a rich variety and greater number of plant and animal species, which are increasingly threatened by ever expanding human activities. The present disk assessment study describes the existing information on the unique Marine Biodiversity of Yemen.

The Yemen coastal is characterized by a narrow coastal plain between the Gulf of Aden and the mountain range that particles the shoreline. This range averages 1.070 m in height and influences the local weather, especially the wind [9]

The Yemen coastal region is influenced by two distinct monsoon seasons. The months of April, May, September and October are transitional months global pressure patterns re-adjust to the changing incoming solar energy [4].

Yemen has a predominantly semi-arid to arid climate, with rainy seasons during spring and summer, and high temperatures prevailing throughout the year in low- altitude zones. Three large bodies of water affect Yemen's climate: The Indian Ocean (including the Gulf of Aden and the Arabian Sea),and the Red Sea and the Mediterranean Sea. They are sources of moisture for the passing air masses and have an impact on the general atmospheric circulation. The Indian Ocean very significantly influences the position of Western Asia and Eastern Africa and it causes the monsoonal wind system. The presence of the Red Sea produces the so-called Red Sea.

The climate of the Yemen coastal and nearby waters is dominated by hot and extremely arid conditions characteristic of North Africa and peninsula [16]. The area of the Gulf of Aden the Arabian Sea needs intensive hydrographical study. Consequently, the present work was undertaken to study the hydrographical parameters: water temperature, Salinity, dissolved oxygen and hydrogen ion concentration in the Gulf of Aden the Arabian Sea water in front of AL-Mukalla.

Therefore, the results of this investigationcould be considered as a pilot study for further similar studies in the coastal water of the Gulf of Aden the Arabian Sea.

Generally, Marine environment is a complex system and mainly influenced by various physical chemical and biological process at the open ocean is more stable ,compared to the near shore waters, where the interaction with terrestrial makes the variations in hydrographical properties. The water quality depends on both natural processes, such as precipitation erosion, weathering of crustal materials, and anthropogenic processes like urbanization, industrialization, mining and agricultural activities. These two parameters play a dynamic role in nutrient cycling, eutrophication, biota abundance and overall food web dynamics in the estuarine and the coastal ecosystem, whereas surface runoff is a seasonal phenomenon largely affected by the monsoon rainfall.

Study area

Hadhramout Governorate is situated between the limits of 14° 30′ -14° 56′ N, and 49° 07′ 50° 21″ E. Its coastline occupies about 750km of the Yemeni coasts. The study area is located in Hadhramout Governorate and includes five sites namely,Ras-Sharma,Burum, Al -Mukalla, Al-Sheher and Arryidah.

The study area extends from Burum area in the west (14º 35' N and 48° 59′ 537″E) to Arryidah in the east (14º 89' N and 49º15' E) in addition to Ras Sharmah as background (protect area). In general, these coasts are irregular in form, but dominated by sandy bays of varying size separated by promontories of limestone or igneous rocks sometimes of substantial height such as Burum area and Al-Mukalla.

Materials and Methods

Seawater samples were collected from Hadhramout Governorate/Yemen. Locations of these samples were carefully fixed by digital GPS Navigator (Model: KGP-913).Table (1) and Figure (1).

Sixty surface seawater samples were collected from the five sampling sites at Hadhramout coastal area Gulf of Aden, during August 2013 to May 2014. These seawater samples were drown to pre-cleaned plastic bottles (1 L) and preserved in an icebox for further analyses. During sampling, dissolved oxygen (DO) was measured using Winkler method, modified by carritt and carpenter [11].Surface water temperatures were measured with a reverse thermometer attached to the water sampler. Seawater samples were analyzed immediately upon collection using a pH meter (WTW pH 720H, ion lab series), asalinity meter and electrical Conductivity (WTW Cond 720H, ion lab series).

Table (1): Locations of seawater sampling in the study Area

Location	Station	Latitudes	Longitudes
Ras-Sharmah	**1**	**14◦ 49′ 356″ N**	**50◦ 01′ 996″ E**
	2	**14◦ 49′ 289″ N**	**50◦ 02′ 163″ E**
	3	**14◦ 49′ 316″ N**	**50◦ 02′ 358″ E**
Burum	**4**	**14◦ 20′985″ N**	**48◦ 59′ 023″ E**
	5	**14◦ 20′ 954″ N**	**48◦ 59′ 135″ E**
	6	**14◦ 20′ 928″ N**	**48◦ 59′ 238″ E**
AL-Mukalla	**7**	**14◦ º31 198″ N**	**49◦ 09′ 986″ E**
	8	**14◦ 30′ 999″ N**	**49◦ º10′ 145″ E**
	9	**14◦ º30 ′ 720″ N**	**49◦ 09′ 615″ E**
AL-Shaher	**10**	**14◦ 44′ 960″ N**	**49◦ 35′ 877″ E**
	11	**14◦ 44′ 994″ N**	**49◦ 35′ 983″ E**
	12	**″14◦ 44′ 931″ N**	**49◦ 35′ 779″ E**
Arryidah	**13**	**15◦ 02′ 735″ N**	**50◦ 33′ 397″ E**
	14	**15◦ 02′ 714″ N**	**50◦ 33′ 612″ E**
	15	**″15◦ 02′ 689″ N**	**50◦ 33′ 827″ E**

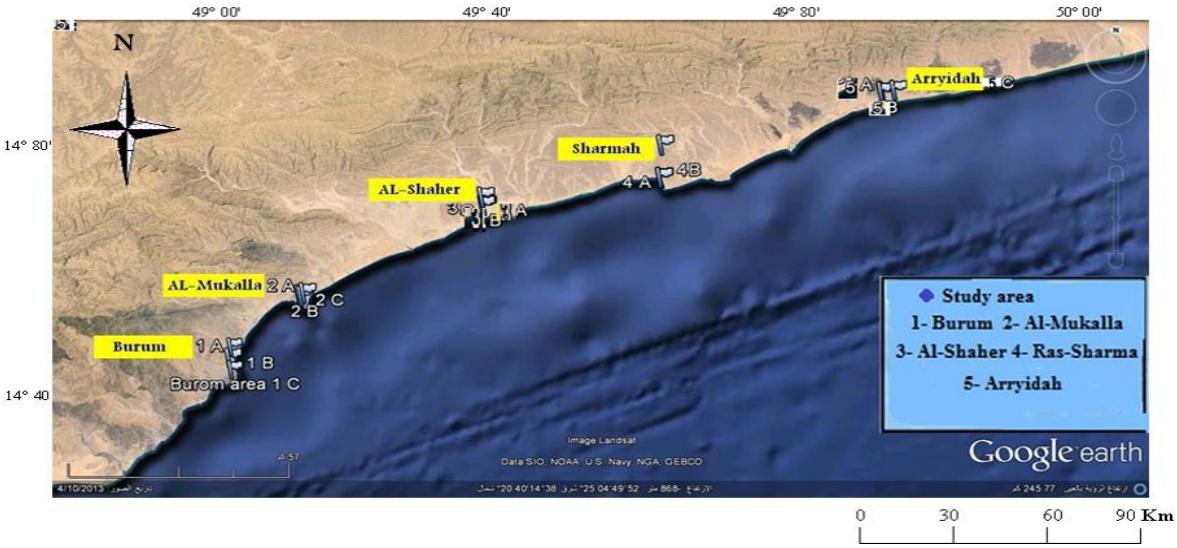

Figure. (1): Map showing of the collected seawater samples in the Study Area
(Source: Google Earth)

Results and Discussion

1- Hydrogen Ion concentration (pH):

Hydrogen ion concentration plays important roles in many of the life processes in the sea, that living organisms depend on, and sensitive to pH. It depens on the interaction of numerous substances dissolved in water, photosynthetic activity of aquatic plants, respiration of aquatic organisms, decomposition of organic matter, precipitation and /or dissolution of CO_2 components and oxidation-reduction reactions. CO_2 complex is the single most important factor that controls the pH in aquatic systems [3].

The results of seawater pH values found during this study are quite similar to those recorded in several earlier studies [2, 3, 4, 6, 8, 10 and 18,].The general pattern of the surface horizontal distribution of pH gave local variation mainly due to the climatic conditions, and consequently water temperature, as well as dissolved oxygen content and biological activity, [14]. Photosynthetic activity in the surface seawater participated in the slight increase in surface pH values [15].

The present results revealed that, pH values of Hadhramout coastal area lie in the alkaline side (pH>7) during the investigated period. The regional and seasonal pH values showed narrow variation during the course of this study. pH values for all stations are within the permissive range (6.5-8.5) according to WHO [21].. Table ((2), (3), (4), and (5)) and Figure (2)

2- Water temperature:

Temperature is one of the major factors, which directly affect animal and plant life in the fresh water. It affects the aquatic organisms as well as physicochemical characteristic of water [20].

Temperature has been identified as the primary abiotic factor controlling key physiological, biochemical and life history processes of fish [1].Temperature, the most easily measured variable, is a critical factor influencing aquatic ecosystem either chemically or biologically. Temperature changes according to many variables such as season, daytime, depth, tide, wind, current, water inflow and turbidity [17].Surface seawater temperature in the study area were recorded in Tables ((2), (3), (4), and (5)) and Figure (3)which shows, in general, no variation of temperature of surface seawater.

The surface seawater temperature in Hadhramout coastal area range from 24.3ºC to 31.4ºC during the time of sample collections, which are in agreement with the results of Al-Alimi[2]and Bawazer[10].The seawater surface temperature in the Gulf of Aden is influenced by the air temperature, ocean currents, and mixing effects of wind and waves. The winds are westernly

during summer monsoon (June – September). The highest surface temperature 30.00-31.00 and northeasterly during winter monsoon November – March (the cooling of the surface temperature takes place and the temperature falls steadily but not evenly to about 24-25) [2].

3- Electrical conductivity

Dissolved ionic compounds increase the conductance of water. Conductance increases and decreases with salinity, and conductivity may also reveal point source of pollution sources, which is below a wastewater discharge.

In the present study, the concentrations of electrical conductivity were recorded in Table ((2), (3), (4), and (5)) and Figure (4) values of electrical conductivity fall between 51.7 ms/cm to 52.8 ms/cm.in surface water. Distribution of electrical conductivity (ms/cm) in surface waters of study area.

The highest concentrations of electrical conductivity were detected in surface water of station 11(Al-Shaher),which indicated that the conductivity increased. This is mainly due to the presence of high content of anion and cation resulting from the discharge of domestic and agricultural wastes at this station [12]. In addition, the conductivity increases with the increase in total dissolved solids and water temperature [13].

4- Salinity

Salinity has been viewed as one of the most important variables influencing the utilization of organisms in estuaries. Salinity is very important limiting factor, which affects the biological distribution of the marine environment. Salinity is simply a measure of the amount of total dissolved salt in water. Physical environments of coastal areas in which marine coastal forms inhabit are so influenced by river water, run-off, precipitation, tidal current, various wastes water by anthropogenic activates, ets..., which is the specific gravity of sea water varies drastically. The main factors controlling the distribution of salinity in the Gulf of Aden are; (1) the evaporation from the surface of the sea, (2) the inflow via the strait of Bab-AL-Mandab of highly saline Red sea water, (3) the flow of water from Arabian Sea, which is considerably of low salinity. There are detectable seasonal changes in salinity along the southern Yemen coast. In general, surface water salinity in this area varies between (33.7-37 PSU ‘’Pressure standard units”) [3].

The surface seawater salinity ranges and averages are listed in Table ((2), (3), (4), and (5)) and Figure (5). Table((2), (3), (4), and (5)) shows no variation of salinity between surface seawater samples and through the sampling stations. The average salinity valueof surface seawater samples is 34.9 which is similar to the salinity value recorded in March 1997 and November- January 1998 byBawazir[10], which recorded during March-April 2005 by Al-Alimi[2] and which recorded during February 2008 by Al-Habshi[3]. The increase in salinity in recent years reflects the global warming effects.

5– Dissolved Oxygen (D.O):

Dissolved oxygen is vital to aquatic life, as it is needed to keep organisms alive. Coastal waters typically require a minimum of 4.0 mg/l and do better with 5.0 mg/l of oxygen to provide for optimum ecosystem function and highest carrying capacity [19].Main source of oxygen is aquatic plants also provide atmosphere, but much during photosynthesis, oxygen may fall to unhealthy levels if water is polluted. Example, if sewage and other wastes (e.g. from food processing) with high Biological Oxygen Demand (BOD) are discharged into the sea.

Dissolved oxygen depletion could suppress respiration, cause death of fish, depress feeding or affect embryonic development and hatching success due to oxygen starvation. This could lead to reproductive failure, stock-recruitment failure at the population level or changes in the composition, abundance and diversity of species at the community level. Index of water pollution is the decrease of oxygen level measured by Dissolved Oxygen (DO) levels. Oxygen is removed from the water as organic matter decays [1].Dissolved oxygen is considered as an important parameter for the identification of different water masses and in assessing the degree of aquatic pollution.

The surface water of the Gulf of Aden and the Arabian Sea along the coast of Yemen contained sufficient amount of dissolved oxygen. In the present study, the concentration of dissolved oxygen values ranges from 5.2 mg/L to 6.8 mg/L. these fluctuations may be attributed to several hydrographic and biological conditions prevailed at various locations.

The DO values showed decrease in Burum station, this is mainly attributed to increase of wastewater contamination at this station, in addition to the oxidation of organic matter by the microbial activity of microorganism. In addition, the decrease in dissolved oxygen in the above stations may be due to the effect of sewage and agricultural wastes discharged at these areas. Table((2), (3), (4) and (5)) and Figure (6).

CONCLUSION

The result shows that the hydrographical parameters exhibited distinct variations by different seasons. The fluctuation of Temperature, pH, salinity, and Dissolved Oxygen are seen in the Monsoon and Non-Monsoon seasons. Salinity was found to be low during August season; it is due to the large amount of Water input along the coast during the monsoon. The increase of dissolved oxygen during May season is attributed to several hydrographic and biological conditions prevailed at various stations. The present baseline information is useful for the further Ecological Monitoring and assessment along the coastal waters.

Table (2): Parameters in surface seawater of study stations during August 2013

location	Stations	pH	Temperature (^{o}C)	Electrical conductivity (ms/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)
Ras-sharma	**1**	**8.22**	**28.90**	**51.70**	**34.20**	**7.10**
	2	**8.24**	**26.10**	**51.60**	**34.20**	**7.00**
	3	**8.24**	**30.00**	**51.90**	**34.20**	**6.50**
Burum	**4**	**8.02**	**25.70**	**52.00**	**34.10**	**6.20**
	5	**8.02**	**25.10**	**52.10**	**34.30**	**5.20**
	6	**8.12**	**24.30**	**51.90**	**34.20**	**5.70**
Al-Mukalla	**7**	**8.13**	**27.50**	**52.00**	**34.30**	**6.10**
	8	**8.22**	**27.40**	**51.80**	**34.10**	**5.80**
	9	**8.04**	**26.50**	**51.80**	**34.20**	**6.60**
Al-Shaher	**10**	**8.17**	**30.50**	**51.80**	**34.30**	**6.80**
	11	**8.22**	**29.10**	**51.80**	**34.20**	**60**
	12	**8.28**	**29.00**	**51.80**	**34.30**	**6.80**
A**rryidah**	**13**	**8.19**	**29.90**	**51.70**	**34.20**	**6.50**
	14	**8.28**	**27.20**	**51.80**	**34.20**	**6.80**
	15	**8.26**	**29.50**	**51.80**	**34.10**	**6.70**
Minimum		**8.02**	**24.30**	**51.60**	**34.10**	**5.20**
Maximum		**8.28**	**30.50**	**52.10**	**34.30**	**7.10**
Average		**8.18**	**27.74**	**51.84**	**34.21**	**6.36**

Table (2): Parameters in surface seawater of study stations during August 2013

location	Stations	pH	Temperature (ºC)	Electrical conductivity (ms/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)
Ras-sharma	**1**	**8.22**	**28.90**	**51.70**	**34.20**	**7.10**
	2	**8.24**	**26.10**	**51.60**	**34.20**	**7.00**
	3	**8.24**	**30.00**	**51.90**	**34.20**	**6.50**
Burum	**4**	**8.02**	**25.70**	**52.00**	**34.10**	**6.20**
	5	**8.02**	**25.10**	**52.10**	**34.30**	**5.20**
	6	**8.12**	**24.30**	**51.90**	**34.20**	**5.70**
Al-Mukalla	**7**	**8.13**	**27.50**	**52.00**	**34.30**	**6.10**
	8	**8.22**	**27.40**	**51.80**	**34.10**	**5.80**
	9	**8.04**	**26.50**	**51.80**	**34.20**	**6.60**
Al-Shaher	**10**	**8.17**	**30.50**	**51.80**	**34.30**	**6.80**
	11	**8.22**	**29.10**	**51.80**	**34.20**	**60**
	12	**8.28**	**29.00**	**51.80**	**34.30**	**6.80**
A**rryidah**	**13**	**8.19**	**29.90**	**51.70**	**34.20**	**6.50**
	14	**8.28**	**27.20**	**51.80**	**34.20**	**6.80**
	15	**8.26**	**29.50**	**51.80**	**34.10**	**6.70**
Minimum		**8.02**	**24.30**	**51.60**	**34.10**	**5.20**
Maximum		**8.28**	**30.50**	**52.10**	**34.30**	**7.10**
Average		**8.18**	**27.74**	**51.84**	**34.21**	**6.36**

Table (3): Parameters in surface seawater of study stations during November 2013

location	Stations	pH	Temperature (ºC)	Electrical Conductivity (ms/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)
Ras-sharma	**1**	**8.25**	**27.20**	**52.50**	**34.70**	**6.40**
	2	**8.33**	**27.20**	**52.50**	**34.80**	**6.30**
	3	**8.38**	**26.60**	**52.60**	**34.80**	**6.40**
Burum	**4**	**8.00**	**26.20**	**52.20**	**34.50**	**6.00**
	5	**8.20**	**26.10**	**52.10**	**34.60**	**6.10**
	6	**8.22**	**26.10**	**51.90**	**34.50**	**6.20**
Al-Mukalla	**7**	**8.23**	**27.70**	**52.00**	**34.60**	**5.80**
	8	**8.22**	**27.40**	**51.90**	**34.60**	**6.20**
	9	**8.14**	**26.80**	**51.80**	**34.60**	**6.40**
Al-Shaher	**10**	**8.47**	**27.60**	**52.40**	**34.90**	**6.30**
	11	**8.37**	**26.60**	**52.10**	**34.80**	**6.20**
	12	**8.62**	**27.20**	**52.80**	**34.90**	**6.30**
A**rryidah**	**13**	**8.11**	**27.10**	**52.60**	**34.80**	**6.30**
	14	**8.14**	**27.20**	**52.40**	**34.80**	**6.30**
	15	**8.20**	**27.10**	**52.50**	**34.70**	**6.30**
Minimum		**8.00**	**26.10**	**51.80**	**34.50**	**5.80**
Maximum		**8.62**	**27.70**	**52.80**	**34.90**	**6.40**
Average		**8.26**	**26.94**	**52.29**	**34.72**	**6.22**

Table (4): Parameters in surface seawater of study stations during February 2014

location	Stations	pH	Temperature (ºC)	Electrical conductivity (ms/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)
Ras-sharma	**1**	**7.90**	**27.00**	**51.90**	**34.80**	**6.90**
	2	**7.90**	**27.20**	**51.90**	**34.80**	**6.80**
	3	**8.00**	**26.50**	**51.90**	**34.70**	**6.80**
Burum	**4**	**8.00**	**26.90**	**52.30**	**34.60**	**6.70**
	5	**8.10**	**26.90**	**52.10**	**34.70**	**6.70**
	6	**8.10**	**26.60**	**51.70**	**34.70**	**6.70**
Al-Mukalla	**7**	**7.90**	**26.60**	**51.90**	**34.60**	**6.60**
	8	**7.90**	**27.00**	**51.80**	**34.70**	**6.70**
	9	**8.00**	**27.00**	**51.80**	**34.60**	**6.60**
Al-Shaher	**10**	**8.22**	**28.40**	**52.40**	**34.90**	**6.50**
	11	**8.22**	**29.20**	**52.20**	**34.80**	**6.50**
	12	**8.23**	**28.40**	**51.90**	**34.80**	**6.40**
A**rryidah**	**13**	**8.10**	**28.70**	**51.90**	**34.80**	**6.70**
	14	**8.20**	**28.20**	**51.80**	**34.70**	**6.80**
	15	**8.20**	**28.40**	**51.90**	**34.70**	**6.70**
Minimum		**7.90**	**26.50**	**51.70**	**34.60**	**6.40**
Maximum		**8.23**	**29.20**	**52.40**	**34.90**	**6.90**
Average		**8.06**	**27.57**	**51.97**	**34.73**	**6.67**

Table (5): Parameters in surface seawater of study stations during May 2014

location	Stations	pH	Temperature (ºC)	Electrical Conductivity (ms/cm)	Salinity (‰)	Dissolved Oxygen (mg/L)
Ras-sharma	1	8.43	31.20	52.30	34.70	6.70
	2	8.40	31.20	51.90	34.80	6.80
	3	8.38	30.60	51.90	34.80	6.70
Burum	4	8.24	27.60	52.70	34.70	6.30
	5	8.22	27.70	52.40	34.60	6.50
	6	8.22	27.60	51.90	34.70	6.50
Al-Mukalla	7	8.33	28.60	52.00	34.70	6.60
	8	8.32	28.40	52.60	34.80	6.70
	9	8.38	28.20	52.20	34.80	6.50
Al-Shaher	10	8.59	30.90	51.80	34.90	6.40
	11	8.77	31.40	52.50	34.80	6.50
	12	8.58	31.10	51.70	34.90	6.40
Arryidah	13	8.43	30.10	51.90	34.80	6.70
	14	8.28	30.20	51.90	34.80	6.70
	15	8.47	29.70	51.80	34.70	6.60
Minimum		8.22	27.60	51.70	34.60	6.30
Maximum		8.77	31.4	52.70	34.90	6.80
Average		8.41	29.62	52.11	34.78	6.57

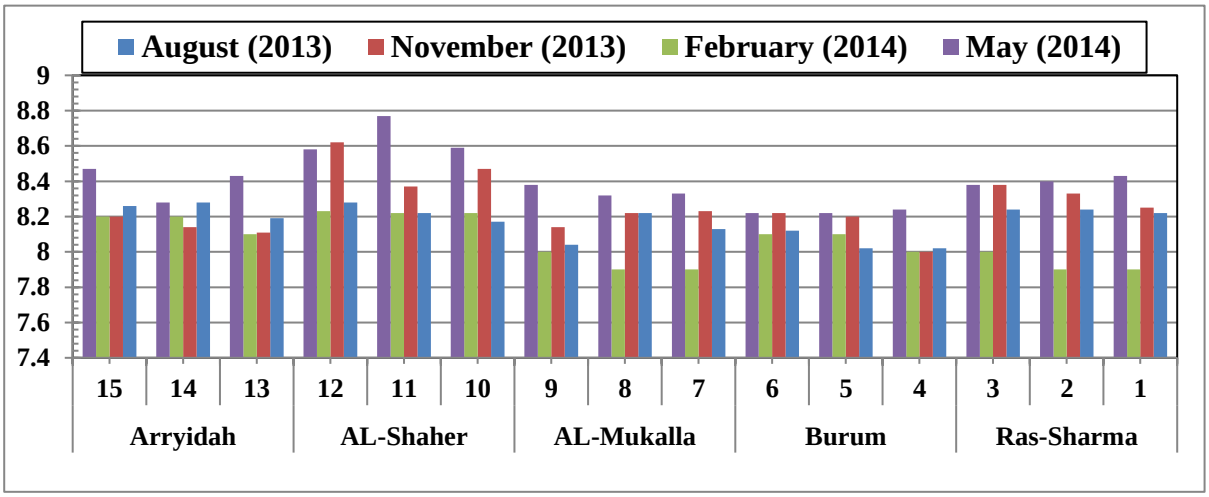

Figure (2): pH of the surface seawater samples in the different sampling periods

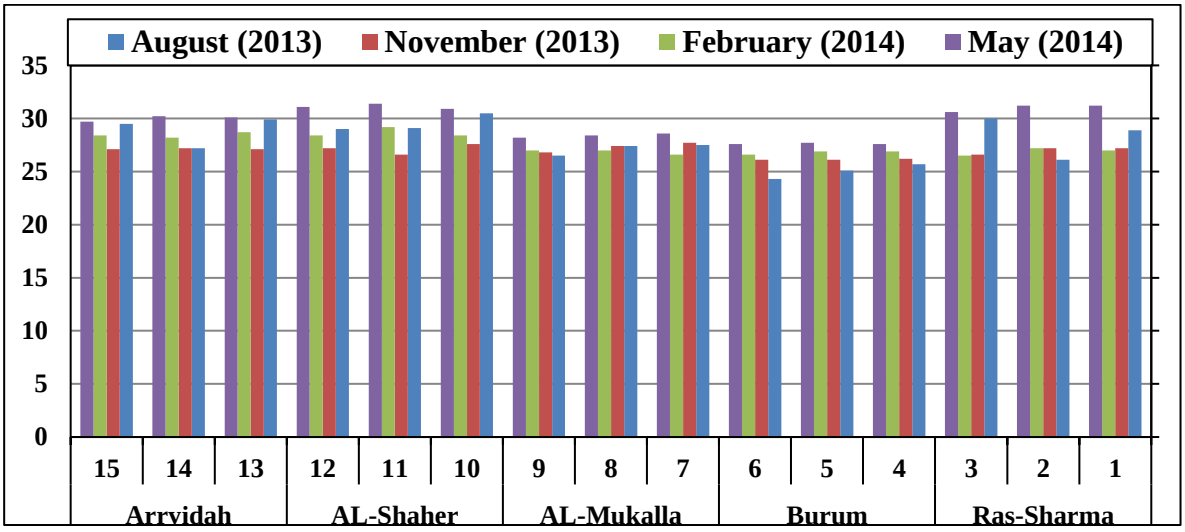

Figure (3): Temperature of the surface seawater samples in the different sampling periods

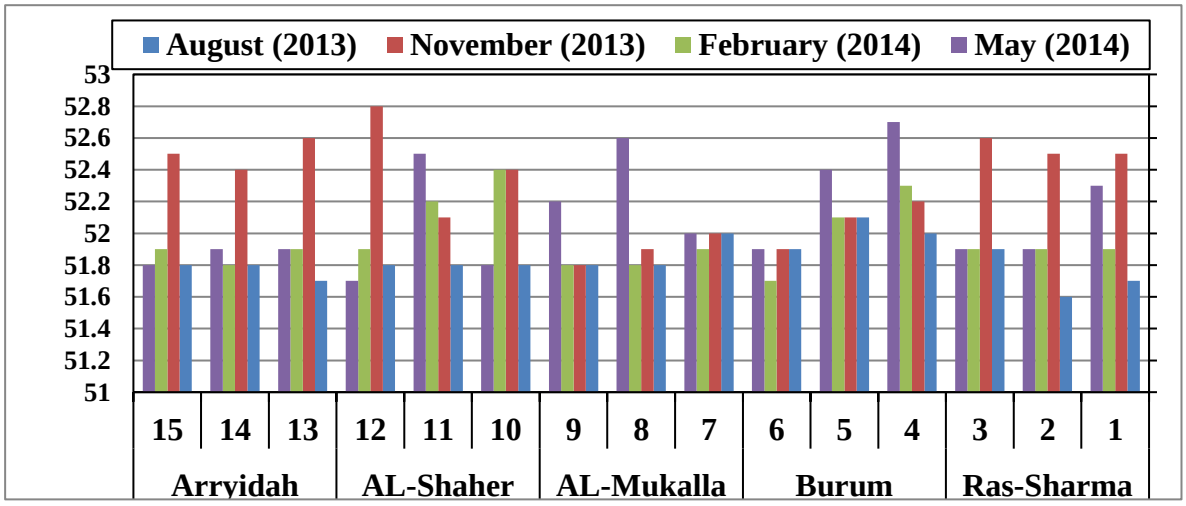

Figure (4): Electrical conductivity of the surface seawater samples in the different sampling periods

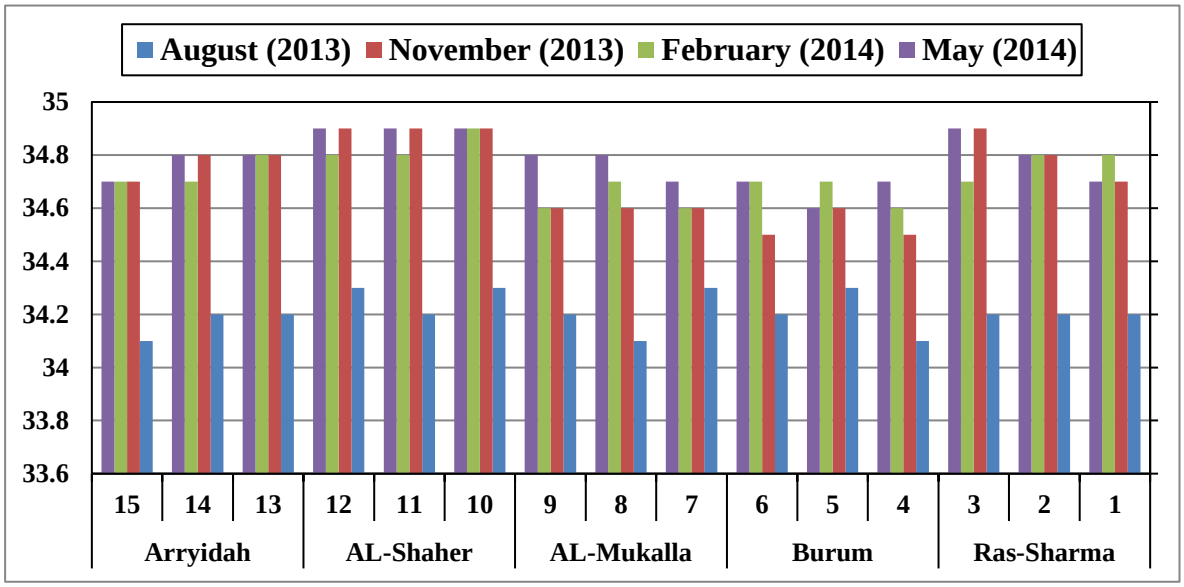

Figure (5): Salinity of the surface seawater samples in the different sampling periods

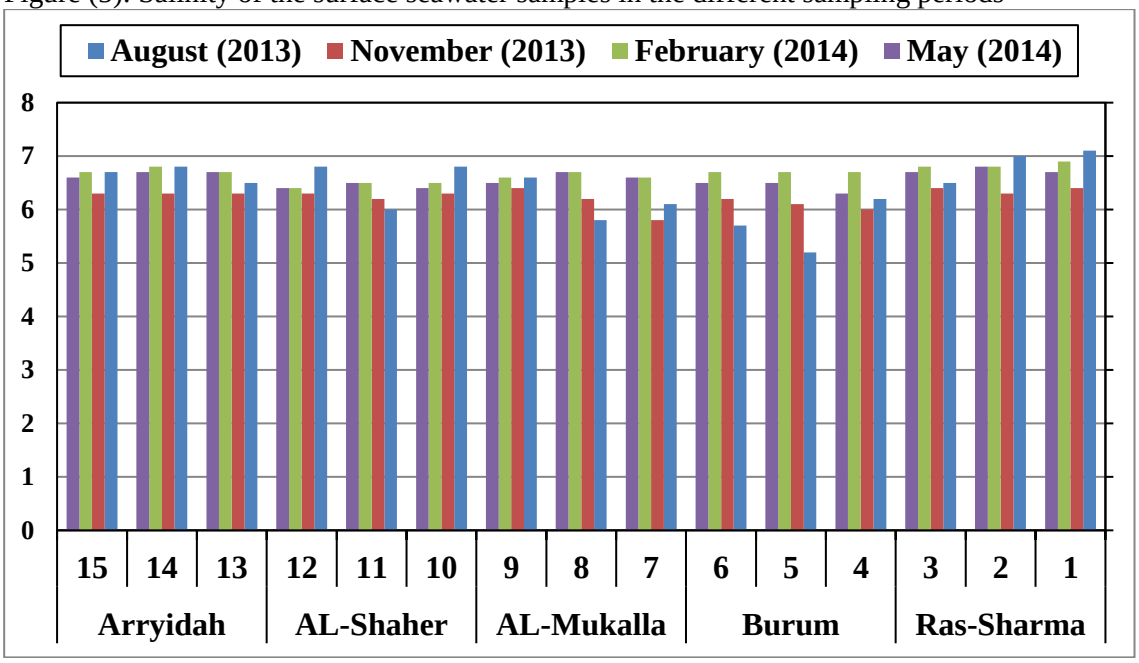

Figure (6): Dissolved oxygen of the surface seawater samples in the different sampling periods

References

1- **Abowei, J. 2010.**Salinity, Dissolved Oxygen, pH and Surface Water Temperature Conditions in Nkoro River, Niger Delta, Nigeria. Advance Journal of Food Science and Technology ISSN: 2042-4876.

2- **Al-Alimi, A. A. 2008.** Assessment of sources and levels of paesistent organic pollltant (POPS) and trace metals in the coastal environment of Hadhramout governorate, Yemen. ph.D.Thesis, Faculty of science , Alxendaria University, Egypt.

3- **AL-Habshi, N. O. N. 2010**. Foraminferal proxies for pollution monitoring in AL-Mukalla coastal area, Hadramout Governorate, Republic of Yemen. Ms. D. Thesis, Faculty of Science, Alexandria University, Egypt.
4- **Al-Kahali, M. S. H., Ba-Isa, A. A. and Al-Shawafi, N. A. 2002**. Marine pollution of Hadhramout coast by heavy elements. Bulletin Environmental Research 5, 65-72, Assute University, Egypt.
5- **Al-Shwafi, N. 2001.** Beach tar along the Red Sea coast of Yemen "Quantitative Estimation and Qualita- tive Determination", ph.D Thesis, Dep. Earth and Environmental Science, Fac. Sci., Sana'a Univ, 186 p.
6- **Al-Shwafi, N. 2003.** Distribution of trace metals in sediment of red sea coat of Yemen. J FacEduc, Ain Shams University, Cairo, Egypt 28:117–126
7- **Al-Shwafi, N., Al-Kahali, M., and Ba-Isa, A. 2003.** Trace Elements Contents in sea Water along 200 km strip of the Hadramout Coast. Journ.ofNat.AndApp.sci University of Aden, vol. 7 No.2. 251-256.
8- **Al-Shwafi, N. and Ahmed, M. 2010.** Litter on the beaches of the Red Sea of Yemen. Journal of Environmental Chemistry. Germany. 19 (2): 123-129
9- **Ba-Sumaid, A.A. 1997.** Effects of Masila oil Terminal on coastal Fauna M.Sc. Thesis, Dep. Biology, Fac. Sci, Sana'a univ, 133 p.
10- **Bawazer, A. S., 2000**. Comparative Study on Biology and Ecology of Mussels Pernaperna, Linnaeus from tropical Region (Gulf of Aden) and (Mytilustrossulus, gould 1850 from Boreal Region (Gulf of Gdansk). Ph.D. thesis, University of Gdansk, Poland. pp: 174.
11- **Carritt, D. and Carpenter, J. 1966.** Comparison and evaluation of currently employed modification of the Winkler method for determination dissolved oxygen in seawater. A NASCO report. J. Mar. Res., 24 (3): 286-318.
12- **Elewa, A. A.,Shehata, M. B. and Abdo, M. H.2001.** Effect of Thermal pollution of Shoubra El –khema Electric station on River Nile water quality. Proc. 2nd Inter-national Conference and Exhibition for life and Environment 3-5 April 2001.
13- **Entz, B. A. G. 1973**. The morphology of Lake Nasser, Lake Nasser development center. RPA, UNDPISF, FAO Aswan. Egypt, 18 pp
14- **Hanna, R.G.M.,Saad, M.A.H. and Kandeel, M.M. 1988.** Hydrographical studies on the Red Sea water in front of Hurgada, Marina Mesopotanica 2: 139-156.
15- **Hemeda, I.I. 1982**. Chemical studies on the water of the Western Harbour of Alexandria.
16- M.Sc. Thesis, Fac. Sci., Alex. Univ.
17- **Howe, G.H., Reed, L.J.;Ball, J.J., Fisher, G.E. and Lasso, W.G.B. 1968.** Classification of world desert areas. Report 69-38ES, Earth Science laboratory, United States Army Natick, laborites Natick,MA.
18- **Moawad, M. N. 2010.**Biosorption for some heavy metals in marine environment (EL-Mex Area). Ms. D. Thesis, Faculty of Science, Alexandria University, Egypt.
19- **Mol- AlDwila, N. S. 2012**. **N. S. 2012**. Waste management of effluents of seafood processing as optional coastal area pollution, Hadramout Governorate, Republic of Yemen. Ms. D. Thesis, Faculty of Science, Alexandria University, Egypt.
20- **UNESCO/WHO, 1978**. Water quality survey. Studies and reports in hydrology, No. 23. Paris: United Nation Educational Scientific and Cultural Organization and World Health Organization.
21- **Turker, H., Eversole, A.G. and Brune, D.E. 2003.** Effect of temperature and phytoplankton concentration on Nile tilapia *Oreochromisniloticus*(L). Filtration rate Aquaculture. Res., 34: 453-459
22- **WHO World Health Organization 1996.** Guidelines for drinking water quality, vol. 2, 2nd ed)Geneva: World Health Organization.

دراسة الخصائص الهيدروغرافية في المياة الساحلية على طول ساحل حضرموت – اليمن

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الملخص

تم جمع البيانات من خمسة مواقع من ساحل حضرموت(راسشرمة،بروم،المكلا، الشحر والريدة) موسمياً من آب / أغسطس 2013 إلى أيار/ مايو 2014 حيث تم قياس الخصائص الفيزيائية والكيميائية لماء البحر، فوُجد أنَّ الخصائص الفيزيائية والكيميائية لمياه البحر لها تغيرات موسمية كبيرة داخل الساحل تتراوح بين -7.9 8.8و 24.3درجة مئوية الى31.4 درجة مئوية و52.8- 51.7 مللي/ سم و 6.8- 5.2ملغم / لتر لدرجة الحموضة في الماء ودرجة الحرارة، الموصلية الكهربائية والأوكسجين المذاب، على التوالي .حيث كان التركيز الأعلى لدرجة الحموضة ودرجة الحرارة في شهر مايو في المحطة 11 في حين كان تركيز الأوكسجين المذاب مرتفع نسبياً خلال أغسطس في المحطة 14,12,10، في حين كانت الملوحة عند أدنى مستوى لها خلال هذه الفترة في المحطة 15,4. 8 ، وتعكس النتائج التي تم الحصول عليها أثر المنطقة الاستوائية الدافئة لخليج عدن وبحر العزب والطوبوغرافيا غير النظامية، والظروف الهيدروغرافيةالمحلية، و التيار السطحي.

الكلمات المفتاحية: المياه الساحلية، الصفات الفسيوكيمائية، التباين الفصلي، ساحل حضرموت، اليمن.