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Determination of Heavy Metals Concentrations in Different Depths in Persian Gulf (Bandar Abbas Region) in Warm and Cold Seasons

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Abstract— *Heavy metals removal is one of the most important environmental considerations in aquatic areas which has been the center of attention globally these days. Concentrations of such pollutants in Persian Gulf as a significant location in the West Asia where a lot of transportation is done daily was studied in this research and the amount of Zn, Cu, Pb, Fe and Mn were measured in Summer and Winter in depth of 3,10 and 15 meters in Bandar Abbas station. Based on the accurate measurements and analysis it was determined that the iron in sediments was more than other pollutants in cold seasons and Mn had the minimum value of contamination in 3 and 10 meter depth and in the 15 meter depth, Pb had the most contamination with concentration of 247 mg/kg and Mn had the least one, 48 mg/kg. Overall it should be mentioned that Mn as a heavy metal with concentration of 47.63 mg/kg represented the least role of pollution in cold seasons. In comparison, in warm seasons Fe polluted the aquatic area more than any other ones and Zn had the least portion with respect of 233.9 mg/kg and 27 mg/kg in all the 3 mentioned depths.*

Keywords— *Bandar Abbas, Cold Seasons, Heavy Metals, Sediments, Warm Seasons.*

I. INTRODUCTION

Strategic location of Persian Gulf has encouraged researchers to consider developing scientific knowledge about environmental problems in different spots. Aquatic environment studies need application of various scientific branches in different points of view, such as oceanography which consists of four categories of split knowledge: study of private physical properties and motion of water, geology studies of ocean zone and sediments, chemical studies of water and all involved solutes and finally biology studies of aquatics. Also oceans can have a basic role by increasing or decreasing temperature while can change concentration of pollutants [1].

So they are the key factors which need a deep progressive development in scientific fields of study. However rapid rambunctious growth in any fields of business without having a deep concept of their environmental effects, have been led to persuade researchers to promote worldwide knowledge and evaluate pollution of surface waters, especially it shines in the regions which are suffered from water absence. In the aquatic environments, sediments play a great important role as the potential sources of carrying and absorbing pollutants.

The concentration of all heavy metals, especially Cu, Fe, Zn, Pb and Mg, which are accumulated in sediments can affect by environmental conditions namely rising salt concentration and minerals, temperature, decreasing of pH-value and activities of microbes, density and etc. [2].

Additionally there is another mechanism that can bring heavy metals back to the aquatic environment which is provided by decreasing dissolved oxygen (DO) while it can decline environment's pH-value and dissolve toxic spices from the sediment to the water. On the other hand variety of industries surrounding Persian Gulf as petrochemicals, fertilizers, natural gas production companies, refineries and some others face this aquatic environment to have irreversible problems.

Also vast ranges of impurities and contaminants have introduced to Bandar Abbas port via social activities and farming, natural resources and mines [3-5] with great negative effects on health while can accumulate in cellular easily, based on the environment conditions [6-8]. However according to the recent mentioned debates, importance of the problem has obviously been clarified and this study tried to evaluate the effect of two different parameters which can affect five various heavy metals concentrations according to depths and seasons. All the researches which were conducted in Bandar Abbas as a port city and the concentration of Cu, Pb, Fe, Mn and Zn ions were measured and clarified.

II. MATERIALS AND METHODS

The considered station, Bandar Abbas, was selected based on the requirements of data analyzing like availability in different seasons and climate conditions, reliability of results to the real conditions and finally considering removal and unloaded points of effluent. However after considering the aforementioned situations and especial urban and industrial pollutant sources, sampling was carried out in two warm and cold seasons in three different depths of 3, 10 and 15 meters at Bandar Abbas station.

Also repeatability of results was evaluated three times. Table I summarized geographic situations of the foregoing station. For all sample providing procedures GERP apparatus used, samples collected and stored in the plastic vessels under 4 ˚C until they were dried, for about 2 or 3 days. For sample preparation, first of all vessels had to be washed with

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concentrate HNO_3 and distilled water and dried under 105 ˚C for three times.

Then 0.05-0.25 g of sediments were introduced into the vessels and 2 ml of concentrate HNO_3 was added and then dried under 80 ˚C. Thereafter 5 ml mixture of the HNO_3/$HCLO_4$/HF were fed to the sediments next they were heated to 120 ˚C since HF acid evaporated and the sediments were dried. At that moment it had to be cooled to the room temperature and drained with 5 ml of HCL 0.1 N and after that fed with equal volume of foregoing acid.

At the next step sediments were introduced into the volumetric flask and extended their volume to 25 ml. In this stage samples were prepared for considered analyzing measurements and were stored in the polyethylene containers. Also it should be mentioned that all analyzing procedures carried out by atomic absorption spectroscopy. On the other hand further data evaluations relied on the statistical analysis by SPSS.

TABLE I. Geographic situations of the under studying zone.

Zone	Geographic Properties	
	Geographic Width	Geographic Length
Bandar Abbas	27˚ 08’ 46” N	056˚ 12’ 06” E

III. Results

A. Determination of Heavy Metals Concentration

By the results it was clarified that sediments of the foregoing zone were contaminated with iron metal more than other pollutants in cold seasons. As depicted in Table II in the cold seasons Mn ions had the minimum value of contamination in three meter depth in contrary with Fe. Also the same order observed in the case of 10 meter depth with concentrations of 31 mg/kg and 586 [1]mg/kg with respect of Mn and Fe.

In the last depth, 15 meter, Pb had the most contamination with concentration of 247 mg/kg and Mn followed the least one, 48 mg/kg. Overall it should be mentioned that Mn heavy metal with concentration of 47.63 mg/kg represented the least role of pollution in cold seasons. In comparison, warm seasons suffered from Fe more than any other ones and Zn had the least portion with respect of 233.9 mg/kg and 27 mg/kg also the three meter depth followed the same trend. Interestingly the two 10 and 15 meters had the similar pattern.

B. Statistical Analysis

It was found that there existed significant differences between concentration of the whole five different heavy metals in the two seasons as analysis of variance (AVOVA) and Tukey test approved it ($p<0.05$) except Mn. Also for the case of Fe and Mn, particular differences between the whole depths were seen by the same analytical methods ($p<0.05$).

By the Pearson test it was confirmed that in cold seasons for all considered depths, a considerable linear relationship was formed between the concentration of Pb and Zn ions as well as Cu and Mn while Fe followed a reverse significant relationship with Pb but direct linear respect occurred between Fe and Zn. But in the case of warm seasons there was a linear connection between Mn with Cu, Fe and Zn and a reverse relation between Cu and Pb as well as Zn and Pb. However Zn heavy metal followed a considerable linear pattern with respect to Fe, Cu and Mn.

TABLE II. Clarification of heavy metals concentrations in sediments at different depths and seasons.

Heavy Metal	Depth	Concentration (mg/kg)[1]	
		Cold Seasons	Warm Seasons
Pb	3	240.69±0.75	77.32±0.23
	10	238.72±0.85	81.25±0.28
	15	247.2±3.9	81.12±2.15
Mean Value	-	242.2±3.9	80.12±2.15
Mn	3	62.72±0.14	61.72±0.51
	10	31.05±0.18	28.3±0.32
	15	48.86±0.26	31.48±0.17
Mean Value	-	47.63±13.86	40.5±15.9
Fe	3	547.23±1.33	334.93±0.19
	10	586.68±0.66	227.67±0.44
	15	168.19±1.15	139.19±0.31
Mean Value	-	434.03±200.12	233.93±84.89
Cu	3	65.35±0.28	64.42±0.08
	10	70.95±0.69	50.56±0.07
	15	66.81±0.4	44.36±.41
Mean Value	-	67.71±2.55	53.11±8.9
Zn	3	96.65±1.31	34.16±0.05
	10	100.08±1	25.69±0.19
	15	106.8±0.17	21.15±0.07
Mean Value	-	101.18±4.63	27±5.72

It can also be mentioned that with respect to other aforementioned heavy metals Mn did not pass through a significant change in concentration for the two seasons, by ANOVA and one-direction variance test. In addition, rest of the foregoing heavy metals provided various polluted sediments for all the three considered depths ($P<0.05$). Overall increasing depth represented remarkable linear reverse connection with respect of Fe and Cu ions concentrations but Fe concentration showed a particular linear pattern respect to any changes occurred in climate conditions ($P<0.05$) in contrast with Cu ions ($P>0.05$) while Zn heavy metal passed through a considerable reverse layout in the two seasons ($P<0.05$).

Finally it should be clarified that in cold seasons increasing depth had direct linear effect of Zn concentration value while warm seasons represented reverse relationships.

IV. Discussion

As it was reported by later studies Bandar Abbas beach has been polluted by heavy metals even more than average amount of other neighbors of surrounding countries such as Qatar, United Arabic Emirates, Bahrain and etc. [9]. This pollution can be raised from many active polluted industries surround the foregoing station such as refineries, mineral materials and petrochemical jetty and power plant of Bandar Abbas while hazardous contaminated effluents unload to Persian Gulf.

The measurements and calculations showed that three meter depths of the station had the most polluted sediments with respect to Fe ions however iron minerals of the surroundings might be responsible for it. Also similarity between Fe and Mg ions in making contamination can be

[1] Mg/kg: milligram/ kilogram of dried sediment

approved via dye industries and their derivatives [10], [11]. Unfortunately in the last decade human-made resources have played the most important role for introducing heavy metals to the environment while aquatic sources are the objectives. On the other hand absorption of product of the reaction between a metal ion and organic ligands can be responsible for rising concentration of this pollutant.

But according to the experiments and measurements done, Pb represented the most contamination in 15 meter depth in cold seasons. This can be explained by the fact that DO decreased in warm seasons and provided a basic environment so toxic elements dissolved to the water from sediments. Also muddy sediments formed in Persian Gulf which can trap contaminants more easily as organic and inorganic compounds so deep depths had more contamination. Also occurring linear reverse relationship between Fe concentration and increasing depth can approve human-made, industrial and natural sources of pollution in the station.

Table III summarizes worldwide standard values of aforementioned heavy metals in comparison with the values in Bandar Abbas.

TABLE III. Standard concentrations of heavy metals in sediments.

	Heavy Metal Type				
	Mg (mg/kg)	**Fe (mg/kg)**	**Cu (mg/kg)**	**Zn (mg/kg)**	**Pb (mg/kg)**
Mean values in the sediments	1000	241	32	95	19
Bandar Abbas	44.11±14.94	334.00±181.23	60.33±9.75	64.00±38.53	161.11±83.51

TABLE IV. Concentration determination of heavy metals in some world regions Vs. Bandar Abbas (in two seasons).

Station	**Heavy Metal Type [12]**				
	Zn (mg/kg)	**Cu (mg/kg)**	**Fe (mg/kg)**	**Mn (mg/kg)**	**Pb (mg/kg)**
Scotland	85	16	1.4	-	9.2
South eastern of England	1.2	44	2.77	-	50
Low Depth in Japan	51	27	3.97	-	55
Kuwait	21	-	1.5	-	23
Saudi Arabia	-	9.9	0.53	-	-
Bandar Abbas, Cold seasons	101.1±4.8	67.6±2.5	434±200.2	47.7±13.9	242.2±3.7
Bandar Abbas, Warm seasons	26.9±5.7	53.1±8.8	234±84.9	40.6±15.9	80±2.01

Table IV also represents the concentration determination of heavy metals in some regions of the world in comparison with the concentration determination in Bandar Abbas in the two studied seasons.

V. Conclusion

Results achieved from the measurements and analysis revealed that among the existed heavy metals in the studied region in summer and winter, Fe in both seasons and in all depths had the most concentrations except in the cold season and in the depth of 15 meter in which the maximum concentration belonged to Pb while the minimum concentration was clarified in Mn in cold season and all the 3 depths and Zn had the least amount as a heavy metal pollutant in hot season in all the depths too. According to this research, in a comparison with the average value in the worldwide sediment this spot had relatively more heavy metal concentrations in almost all measured sediments.

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