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Evaluation of Cu, Zn, Fe, Mn and Pb Concentrations at Three Depths at Bandar Lengeh Port in Persian Gulf in Two Seasons

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Abstract**—** *Among many pollutants in aquatic areas such as seas, oceans, lakes and other water based areas even wastewaters, heavy metals removal is one of the most important environmental considerations which has globally been the center of attention in the current century. Concentrations of such pollutants in Persian Gulf as a significant aquatic 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 Lengeh station as one of the stations for further protection. Based on the accurate measurements and analysis it was determined that Fe in sediments was more than other pollutants in both cold and warm seasons and in all the 3 studied depths while in cold seasons Mn had the minimum value of contamination in 3 and 10 meter depth (41.19±0.06 mg/kg and 47.32±0.32 respectively) and in the 15 meter depth, Cu had the least contamination with concentration of 70.06±0.06 mg/kg. In comparison, in warm season the minimum contamination belonged to Zn in all the 3 studied depths.*

Keywords**—***Bandar Lengeh, Concentration, Heavy Metals, Seasons, Sediments, SPSS*

I. INTRODUCTION

All around the world there are some important strategic points with respect of their especial pollutant properties. Aquatic and earthy environment suffered from various contaminations nowadays, because of nonscientific incrementing of industrial activities, no sustainable development and irregular use of natural resources while objective station of this study is not except from these problems, Bandar Lengeh port [1-3]. This port is located exactly based on the geographic situations which are summarized in table I.

Water pollution not only influences on aquatic environment, but also can exert negative deep economic effects in the case of its treatment processes. There exist many different types of considerable reasons for soil, water and air pollution.

In the case of water pollution it was approved that chemical instruction of sediments depends on various parameters such as availability of pollutant compounds in water, rate of sedimentation, physical and chemical properties of compounds, pH-values, basic characteristics and finally dissolved oxygen [4], [5].

On the other hand special strategic position of any understudying zone as Bandar Lengeh, accounts for degree of severity of contamination while there exist many unclean industries in neighboring of aforementioned station like desalination installation, power plants, Pb concentration faculty, fertilizer effluents, agricultural toxicants and etc. [6]. Recent studies approved that deep rooted depths had better water quality while distance is increased from the pollutant source [2].

Also it should be recalled that unfortunately human sources are responsible for many undesirable effects as it was approved specially for Fe and Zn. Also there are another key factors which exert a main influence on contamination quantity as specification of the earth, local resources, adjacency to the sour rivers and etc. These parameters represented great influence in the case of contaminations with respect to Zn ions [7].

One of the most critical factors is salinity while exerts great effect on water quality [8]. It was approved that for this understudy station salinity reached high values during winters that can be raised from fresh water flows that have minimum values during August to October and Persian Gulf salinity reaches to 36-44 g/l. These aforementioned high salinity can be explained via movement of relatively low salty water from Hormoz neck to the Persian Gulf and then flow though the north of Persian Gulf. As a result water salinity increases even by 40 %. All difficulties mentioned till now, clarify the importance of the problem and encourage us for more scientific analysis of the sediments' quality in Bandar Lengeh station.

II. MATERIALS AND METHOD

Basic structure in the following research puts on the three fundamental roles for zone selection such as available depths for sampling, variety in climate conditions and strategic points of unloading pollutants.

There was a similarity in sample preparation and all experimental procedures as in our previous work [9] and followed by analytical studies by SPSS. All foregoing procedures carried out on the Bandar Lengeh station, one of the most objective locations with great industrial activities surrounding the Persian Gulf (Table I).

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TABLE I. Geographic situations of the under studying zone.

Zone	Geographic Properties	
	Geographic Width	Geographic Length
Bandar Lengeh	26°33′29″N	54°52′50″E

III. RESULTS

A. Concentrations of Heavy Metals with Respect of Depth and Seasons

As depicted in the following the cleanest sediments belong to 10 meter depth of the station in warm seasons with respect to Zn (Table II). Also as it was demonstrated in our previous work Fe heavy metal recorded the worst properties for the sediments of 3 meter depth [9].

TABLE II. Determination of heavy metals concentrations in sediments at different depths and seasons in Bandar Lengeh Station.

Heavy Metal	Depth	Concentration (mg/kg)	
		Cold seasons	Warm Seasons
Pb	3	201.1±0.52	85.25±0.39
	10	212.24±0.85	85.49±0.08
	15	214.87±0.76	89.56±0.21
Mean Value	-	209.39±6.37	86.77±2.11
Mn	3	41.19±0.06	39.26±0.15
	10	47.32±0.32	45.61±0.1
	15	95.39±0.45	94.84±0.09
Mean Value	-	61.3±25.7	59.9±26.35
Fe	3	551.1±.43	317.35±0.07
	10	268.6±0.81	255.73±0.25
	15	278.6±0.72	262.8±0.09
Mean Value	-	366.1±138.8	278.6±29.19
Cu	3	87.93±0.56	55.07±0.06
	10	70.55±0.41	51.17±0.14
	15	70.06±0.06	47.53±0.48
Mean Value	-	76.18±8.82	51.25±3.27
Zn	3	85.39±0.58	33.57±0.01
	10	88.29±0.81	28.85±0.08
	15	94.34±1.45	30.04±0.06
Mean Value	-	89.34±4.04	30.82±2.13

B. Statistical Results

The two Fe and Mn ions had various concentrations in the whole three depths as recommended by analysis of variance (ANOVA) and Tukey test ($P<0.05$). Also the same analytical tests confirmed that the same trends there, existed between the whole five pollutants except Mn ions for the two seasons ($P<0.05$). On the other hand Pearson test clarified that in the cold seasons Pb had a linear particular relationships with both Zn and Mg while represented reverse significant relevance with Fe and Cu.

In addition Mg had direct relationship with Zn and Pb, but revers relation with Cu and Fe. But for the case of warm seasons Pb showed a significant linear and revers connection with Mg and Cu, respectively in different depths ($P<0.05$). Also Mg evaluated to have direct respect with Cu. On the other hand a revers linear respect observed between Zn with Fe and Cu.

Overall it can be concluded that by the ANOVA and one-direction variance test Mg didn't have different concentrations in the two seasons but for rest of heavy metals different depths had various amount of contaminants ($P<0.05$). In this station there existed a deep direct relevance between increasing of depth with the amount of Mg concentration ($P<0.05$) as well as for Zn in the cold seasons. But in the case of warm seasons Zn heavy metal had linear revers relationship with depth.

IV. DISCUSSION

Analytical results clarified that in Bandar Lengeh station, the three meter depth is the most contaminated one with respect of Cu in the cold seasons. By the co-workers it was demonstrated that salinity reached greater values in Persian Gulf during winters which this incrementing accounts for accumulation of pollutant in the sediments [10], [11].

Salinity is not only responsible for pollution of sediment, but also for enhancing hardness. In the low values of salinity availability of Cu^{+2} increased while there is a deep competition between Ca and Mg with oxides of Cu which is more toxic than its natural form.

In comparison of current study with later ones there is a progressive pattern in Cu concentration that can be raised from increasing water hardness. Cu contamination generally happened in the sediments of beaches rather than industrial, agricultural and urban effluents. Also this heavy metal formed a stable complex in the presence of chloride so salinity has a direct relationship with Cu concentration in the sediment. This heavy metal plays a key role in alloy industries especially in the case of brass, Fe and bronze.

On the other hand dye industries utilize this heavy metal in many fields such as shipping industrial, non-corrosive dyes for protection of ships body against ferns and many other microorganisms while all of them release the Cu content to the sea.

Also there are other related concerns while water lines in many houses make of Cu so it can dissolved during years and finally related townships received much more Cu than others [12]. Additionally soil contamination with this heavy metal raised from application of fertilizers and agricultural, urban and industrial effluents as well as erosion of Cu alloys. But fortunately industrial contaminations decreased by increasing distance from the origin. Similarly it was approved by later results that in the two previous centuries that the most contamination results from human resources [13]. Standard values of heavy metal content in the worldwide summarized in table III.

TABLE III. Comparison of worldwide standards and Bandar Lengeh concentrations of heavy metals in sediments.

	Heavy Metals				
	Mn (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Pb (mg/kg)
Mean values in the worldwide sediments	1000	241	32	95	19
Bandar Lengeh	60.61±25.3	322.4±107.3	63.6±14.3	60.1±30.3	148.06±63.23

V. CONCLUSION

Results achieved from the measurements and analysis in Bandar Lengeh Port 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 while

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the minimum concentration was clarified in Mn in cold season and the first 2 depths and Cu had the least amount as a heavy metal pollutant in that season at the third studied depth. Furthermore, Zn had the minimum contamination in all the 3 mentioned depths in warm season. 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 except Zn which was almost two third of the worldwide standard content.

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