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Assessment of Marine Coastal Water Pollution from Karachi Harbour Pakistan

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Abstract: In Pakistan, marine pollution is a major problem that is caused by the waste from industrial, municipal, agronomy, and oil leak sources. The pollutant loads along with the coastline areas near Karachi is received from terrestrial contaminants including discharges from Karachi Harbour located on the estuary of the Lyari river. Karachi generates 472 Million Gallon per Day (MGD) of wastewater out of which only 55 MGD is treated and the rest is discharged in the sea. The prevailing sewage treatment plants are functioning at reduced capacity due to the insufficient transmission capacity of interceptors. Water sampling was carried out from the Lyari River and five different selected coastal point around Karachi harbour for physicochemical parameters and selected heavy metals. Results show that the Karachi Harbour area is noticeably polluted, whereas; the coastal environment in the vicinity of Karachi is also under the stress of pollution. High COD and BOD5 values were noticed at the Lyari river samples and the sampling locations close to the Lyari river outfall area. The Pb, Cd, Ni, and Hg heavy metals that pollute marine water are found. This situation is due to the discharge of mixed effluents of industrial and domestic wastes as well as dredging, cargo handling, dumping of ship waste and other coastal activities. The highest value of pollution observed at Karachi Harbour which is near Lyari river mouth, where the domestic and industrial effluents with organic and inorganic wastes have a greater influence on the water quality and the marine environment. At present, there is no effective controlling mechanism for industries to treat their waste, nor has any investigation to assess increasing marine pollution been carried out. As a result, there is an adverse impact on fish habitat and mangroves, corrosion of cargo ships, naval vessels and the residents living in the coastal area. Therefore, the government agencies and industrial sectors should work together to avert marine pollution and attain total environmental sustainability.

Keywords: Karachi harbour, marine water, Lyari river, pollution, heavy metals.

Introduction

The preparation of sustainable, ecosystem-based guidelines and measures for oceans and coasts should be supported by science containing study and interpretations. Monitoring efforts are specifically essential at a time when the world's oceans, coasts, and marine ecosystems are experiencing great variations triggered by growing coastal pollution, overfishing, greenhouse gases, coastal expansion, or increasing population pressure (Adnan, 2012). The main issue in the territorial waters is the condition of polluted waters, which can reduce the quality of the aquatic environment. The water quality depends on the environment and it is determined by the physicochemical parameters of the waters (Hamuna et al., 2018). The number of large and small rivers flowing in coastal waters will transport agricultural waste, industrial waste, and anthropogenic waste from the mainland (Tanjung et al., 2019). These conditions can interrupt the potential in coastal and marine waters as a source of food for the public (Chen et al., 2007; Tjahjono et al., 2017; Drira et al., 2017). The increasing pollution levels in the coastal regions and degradation of marine resources of the country are emerging as important an environmental threat that needs immediate action.

Pakistan is positioned at the doorway of the Persian Gulf. Marine pollution in Pakistan is the main problem of the seas where the waste is received from the industrial, municipal, household, and oil spill sources. The major waste reception areas in Karachi or nearby adjacent areas from industrial sites of Karachi city dumps into the harbour. Coastal areas near Karachi that receive land-based pollution, including Karachi harbour, are located on the estuary of the Lyari river. Karachi generates 472 MGD of wastewater every day (Tahir, 2017). The capacity of present sewage treatment plants with current operational status is given below.

Only 55 MGD out of the 472 MGD of wastewater and sewage produced by the city is treated, the remaining mix into the sea through natural drains or nallah drains into the Arabian Sea without any treatment which harmfully affects the marine environment. The present sewage treatment plants are functioning at reduced capacity due to the insufficient transmission capacity of interceptors (KWSB, 2015). The main objectives of the study are to collect and analyse marine water samples from different areas around Karachi harbour for physicochemical parameters and selected heavy metals. Comparison of collected data with available national standards.

Material and Methods

Water sampling was carried out from the Lyari river and five different selected coastal points once in high tide and second in low tide in March and June 2020,

(Fig. 1). Each sample was collected replicate from the sea surface and 10 feet in depth. Standard sampling procedures were followed to collect the samples (Table 2).

Table 1 Sewerage Treatment Plants in Karachi.

Sewerage Treatment Plants	Optimum Design Capacity	Actual Treatment
STP-I – SITE	51 MGD	20 MGD
STP-II –Mehmoodabad	46.50 MGD	00 MGD
STP-III – Mauripur	54 MGD	35 MGD
Total	**151.50 MGD**	**55 MGD**

Sources: (Tahir, 2017)

Certain physical and chemical properties of water, such as pH, temperature, salinity and total dissolved solids were noted at the sampling locations with the help of Portable HACH SensION 156. Chemical parameters were determined by HACH Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) Track. Metal contents (Pb, Cd, Ni and Hg) in the samples were determined with the help of a Thermo ice 3000 Atomic Absorption Spectrophotometer. The collected samples were analyzed for selected physicochemical parameters and heavy metals conducted in the Environmental Research Center (EPA and ISO Certified Laboratory)

Bahria University Karachi Campus.

Table 2 Sample locations.

Sample Location	S. Number	Coordinates	
Lyari River Sample	Lyari River Sample	24°52'16.80"N	66°58'30.61"E
Lyari River Out Fall Area	LS-1	24°50'46.82"N	66°58'21.65"E
	LS-3	24°50'35.14"N	66°58'1.16"E
Shipyard Area	S-1 A	24°50'19.58"N	66°58'18.17"E
	S-1 C	24°50'17.49"N	66°58'3.74"E
KPT Area	S-2 A	24°49'17.34"N	66°58'22.00"E
	S-2 C	24°49'6.41"N	66°58'13.48"E
Kemari Harbour Area	S-3 A	24°49'3.18"N	66°58'32.03"E
	S-3 C	24°48'51.26"N	66°58'23.54"E
Dockyard Area	S-4 A	24°49'44.19"N	66°58'6.92"E
	S-4 C	24°49'39.63"N	66°57'53.80"E

Results and Discussion

Water samples were analyzed for physicochemical parameters and heavy metals. Data produced from Lyari river samples were compared with the available Sindh Environmental Quality Standards (SEQS) guideline (where applicable). For marine pollution, there is no general standard available at SEQS and the national level.

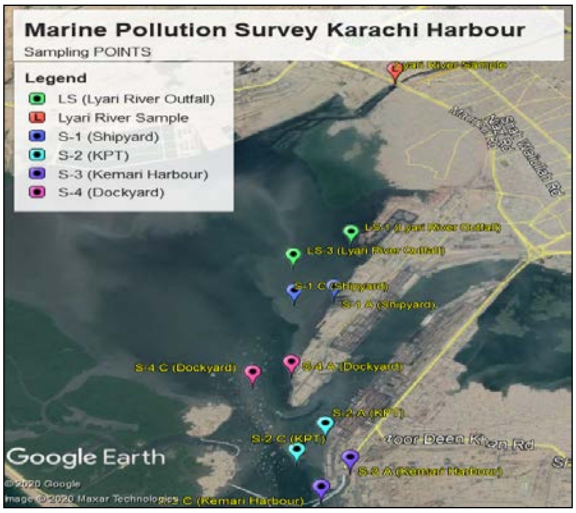

Fig. 1 Marine pollution survey, Karachi Harbour sampling points.

Lyari River Samples

Temperature, pH and TDS ranges of both Lyari river tail samples were found within the SEQS permissible limit and effluent influx may not have adverse effects on coastal areas.

COD of both Lyari river tail samples were found 654 mg/l (high tide) and 572 mg/l (low tide). Values of COD in both samples were significantly higher than the SEQS limits. BOD of both Lyari river tail samples was found 362 mg/l (high tide) and 291 mg/l (low tide) as shown in Table 2. Values of BOD at both samples were significantly higher than the SEQS limits. This elevated concentration is due to SITE Industrial effluent mixing with municipal effluent of Lyari river flow final drain into the sea. Furthermore, unprocessed domestic waste from the adjacent communities is also thrown into the creek area.

Heavy metals Pb, Cd, Ni and Hg were determined from Lyari river tail samples. Pb in both Lyari river tail samples was found within the permissible limits. The Cd and Hg concentrations are in both samples were slightly higher or nearby the SEQS permissible limits.

Ni in both Lyari river tail samples was found 5.6598 mg/l (high tide) and 3.5914 mg/l (low tide) (Table 2). Values of Ni in both samples were significantly higher than the SEQS limits. The high concentration of Ni in the Lyari river is due to the waste originating from the electroplating industries at S.I.T.E.

Seawater Samples

Seawater Surface Samples (High Tide)

Variation in temperature, turbidity, TDS, and salinity of all surface and depth seawater samples at high and low tide along the Karachi Harbour is due to the mixing of seawater with the massive release of unprocessed wastewater comprising severely contaminated pollutants by the Lyari river.

The organic contamination burden in water frames is usually recognized through COD and BOD_5. High COD and BOD_5 values were observed at the sampling sites adjacent to the Lyari river outfall area (LS-1, LS-3, S-1A, and S-1C). The highest value observed at Karachi harbour which is near Lyari river mouth showed the gradual deterioration of the water quality due to continuous discharge of domestic and industrial wastes of Karachi. Data reveals that the western backwaters of Karachi harbour where the domestic and industrial effluents bring organic and inorganic wastes through Lyari river have a greater influence on the water quality that is badly affecting the marine environment of these areas which is causing de-oxygenation of the poorly oxygenated area. Furthermore, unprocessed domestic waste from the adjacent communities was also discarded into the harbour area. This high volume of unprocessed

Table 2 Lyari river sample & physiochemical characteristics-1 & 2 Data.

S.No.	Sampling Site	Physicochemical Parameters						Heavy Metals (mg/l)			
		Temp ^0C	pH --	TDS (mg/l)	Salinity (%)	COD (mg/l)	BOD (mg/l)	Pb	Cd	Ni	Hg
SEQS standard (Into Sea)		40≤3	6-9	3500	--	400	80	0.5	0.1	1.0	0.01
1	Lyari River Sample-1 (March-20)	26.1	7.71	2810	2.8	654	362	0.1328	0.1276	5.6598	0.0176
2	Lyari River Sample-2 (June-20)	31.6	8.22	2196	2.19	572	291	0.1055	0.1009	3.5914	0.0118

Table 3. Seawater surface samples data (high tide)

S.No.	Sampling Site	Physicochemical Parameters						Heavy Metals (mg/l)			
		Temp ^0C	Turbidity NTU	TDS (g/l)	Salinity (%)	COD (mg/l)	BOD (mg/l)	Pb	Cd	Ni	Hg
1	LS-1	23.6	1.34	31.2	32.5	45	23	0.8838	0.8241	15.2370	0.0118
2	LS-3	23.3	0.62	32.3	33.6	37	19	0.5910	0.5804	12.0776	0.0103
3	S-1 A	23.4	0.52	30.8	32.8	24	14	0.6991	0.8656	13.0730	0.0089
4	S-1 C	23.1	0.58	32.5	33.7	29	15	0.4397	0.6859	10.8965	0.0062
5	S-2 A	22.9	1.57	34.5	36.8	56	27	0.2706	0.4032	10.8209	0.0125
6	S-2 C	22.9	0.49	33.4	34.7	48	25	0.1693	0.2005	8.8788	0.0119
7	S-3 A	23.4	0.63	32.8	34.1	46	24	0.4241	0.6768	12.7695	0.0117
8	S-3 C	23.2	0.45	36.5	38.0	47	24	0.1226	0.2673	11.3096	0.0013
9	S-4 A	23.2	0.69	32.6	33.9	49	26	0.5732	0.6607	13.3241	0.0016
10	S-4 C	22.9	0.51	33.0	34.2	38	21	0.3278	0.5891	9.9213	0.0011

Seawater Depth Samples (10 Feet) (High Tide)

Table 4 Seawater 10 feet depth samples data (high tide).

S.No.	Sampling Site	Physicochemical Parameters						Heavy Metals (mg/l)			
		Temp ^0C	Turbidity NTU	TDS (mg/l)	Salinity (%)	COD (mg/l)	BOD (mg/l)	Pb	Cd	Ni	Hg
1	LS-1	23.4	1.78	34.4	35.7	106	61	0.9925	0.8995	18.8420	0.0339
2	LS-3	23.0	1.67	35.1	36.1	297	172	0.8211	0.6879	14.5810	0.0284
3	S-1 A	23.4	0.76	33.8	35.2	28	16	0.7220	0.9709	16.9945	0.0171
4	S-1 C	22.9	0.67	34.8	36.2	33	19	0.6713	0.7520	11.3778	0.0086
5	S-2 A	22.6	0.59	35.6	37.9	41	24	0.5670	0.5868	13.9862	0.0192
6	S-2 C	22.7	0.52	36.5	37.9	53	28	0.2459	0.4474	10.8365	0.0115
7	S-3 A	23.1	1.35	36.8	38.3	57	31	0.6133	0.8715	12.9784	0.0162
8	S-3 C	23.0	0.77	36.9	38.8	62	34	0.1997	0.6688	9.3925	0.0150
9	S-4 A	22.9	0.87	35.0	36.4	71	39	0.0906	0.7583	15.2275	0.0297
10	S-4 C	22.7	1.17	36.4	36.7	79	42	0.0757	0.6075	11.7331	0.0211

Seawater Surface Samples (Low Tide)

Table 5 Seawater surface samples data (low tide).

S.No.	Sampling Site	Physicochemical Parameters						Heavy Metals (mg/l)			
		Temp ^0C	Turbidity NTU	TDS (g/l)	Salinity (%)	COD (mg/l)	BOD (mg/l)	Pb	Cd	Ni	Hg
1	LS-1	32.3	1.70	30.1	31.5	2120	910	0.9024	0.9700	16.7673	0.0493
2	LS-3	32.6	1.35	32.0	33.4	2015	830	0.8798	0.6392	13.9764	0.0219
3	S-1 A	32.5	1.87	32.3	33.7	1150	640	0.7187	0.8957	14.4401	0.0116
4	S-1 C	32.3	1.20	33.2	34.7	1010	510	0.6887	0.6945	11.0631	0.0103
5	S-2 A	32.3	2.05	34.4	35.9	2040	870	0.5045	0.4973	13.4021	0.0325
6	S-2 C	32.0	1.68	33.7	35.1	390	174	0.2122	0.2649	12.4319	0.0107
7	S-3 A	32.1	1.68	30.6	32.5	570	220	0.5267	0.7091	16.9830	0.0126
8	S-3 C	31.8	1.57	34.3	35.8	2036	180	0.3796	0.3879	13.6080	0.0093
9	S-4 A	32.5	1.64	33.8	35.2	2098	215	0.7331	0.8095	14.5392	0.0208
10	S-4 C	32.2	1.40	33.8	35.3	750	340	0.6048	0.6002	11.4907	0.0120

industrial and domestic discharges is seriously distressing the creek environment.

Severely affecting levels of heavy metals Pb, Cd, Ni, and Hg in the Karachi fish harbour region might be due to incursion of industrial discharge from electrical appliances, cable, batteries, automobile, electroplating, dyeing, car painting, glass industries, and textile wastewater via Lyari river. The elevated concentrations are due to the continuous flow of unprocessed domestic wastewater from the Lyari river in Karachi harbour, shipping action and the boats which are used for catching fishes.

The high concentration of Ni in Karachi Harbour is due to the waste patenting from the electroplating industries at S.I.T.E. According to (Qadri et al. 2011; Nergis et al. 2012; Jilani, 2018; Alamgir, 2018) Industrial and domestic waste is considered to be the key basis of cadmium in the marine environment. The availability of a high concentration of Pb in seawater samples might be mostly due to the fuel used for fishing boats which commonly use petrol or diesel. The faulty boat sources of the leakage of fuel is also a common problem in the area.

According to (Saleem and Kazi 1995, 1998; Beg 1994; Mashiatullah et al. 2009; Mumtaz 2002; WWF 2002; Azhar et al. 2009; Qadri et al. 2011; Nergis et al. 2012; Jilani, 2018; Alamgir, 2018) the higher concentration of heavy metals in the Karachi coastal water samples. They also concluded that the escalation was mostly due to the pollution load added by the Lyari river in the sea. The higher concentration of metal decreased gradually as the distance of sampling locations increased from the point where the Lyari river joins the sea.

Seawater Depth Samples (10 Feet) (Low Tide)

Table 6 Seawater 10 feet depth samples data (low tide).

S.No.	Sampling Site	Physicochemical Parameters						Heavy Metals (mg/l)			
		Temp ^{0}C	Turbidity NTU	TDS (g/l)	Salinity (%)	COD (mg/l)	BOD (mg/l)	Pb	Cd	Ni	Hg
1	LS-1	32.4	2.95	30.3	31.6	2240	1030	0.9911	0.9764	17.9874	0.0918
2	LS-3	32.6	1.96	31.7	33.0	1992	970	0.8952	0.7359	15.1397	0.0728
3	S-1 A	32.3	3.32	33.0	33.7	1030	490	0.8602	0.9243	15.3997	0.0562
4	S-1 C	32.4	1.53	33.2	34.6	870	380	0.8001	0.6333	13.4538	0.0494
5	S-2 A	32.2	1.61	34.6	36.1	1740	730	0.6271	0.5561	12.3927	0.0411
6	S-2 C	32.1	1.63	33.5	34.9	210	97	0.4958	0.4542	11.5024	0.0289
7	S-3 A	32.1	1.53	30.9	35.6	447	190	0.8050	0.9021	14.0764	0.0216
8	S-3 C	31.5	1.17	34.2	35.6	513	225	0.4128	0.8416	10.0284	0.0118
9	S-4 A	32.1	6.32	34.0	35.4	950	438	0.8870	0.7997	15.7752	0.0227
10	S-4 C	32.2	1.55	33.9	35.4	271	129	0.8024	0.7002	12.6082	0.0209

Conclusion

The seawater quality characteristics found in this study show that the Karachi harbour area has been polluted. The level of organic matter, salinity, the temperature at certain localities indicates that the coastal environment in the vicinity of Karachi is under the stress of an increased level of pollution along the coast. Physicochemical parameters and heavy metal concentration like Pb, Cd, Ni, and Hg metals in seawater of coastal areas are also due to the continuous release of unprocessed industrial and domestic discharge via Lyari river and harbour activities such as rummaging and cargo management, waste disposal and other problems. Coastal areas have heavy metals pollution since continuous pollution records will have an adversative consequence and. immediate remedial action is therefore required to combat pollution in the marine environment of the Karachi coast.

There is no effective mechanism for creating awareness among the general public about the Karachi harbour pollution and its effects on the life of people and marine life. The non-implementation of existing laws have further deteriorated the marine environment in Pakistan.

References

Adnan, (2012). Implementation of polluter pays principle in Pakistan’s corporate legal regime: A comparative analysis with USA and India, (PhD diss. International Islamic University Islamabad, 2012).

Alamgir, A., Khan M. A., Shaukat S. S., Kazmi J. H., (2018). Impact of indiscriminate disposal of untreated effluents in Korangi creek, Karachi, Pakistan. *Applied Water Science*, **8,** 155. https://doi.org/10.1007/s13201-018-0817-4.

Azhar, S., Mumtaz M., Zaigham, N. A., Mallick, K.A., Sumayya, S., Erum, Z., Haider, A. K. (2009). Heavy metal toxicity levels in the coastal sediments of the Arabian Sea along the urban Karachi *(Pakistan)* region. *Mar. Pollut. Bull.*, **58** (9),1406–1419.

Beg, M. A. A. (1994). Pollution in the marine environment of Karachi. *Wildlife Environ.*, **3**, 36–41.

Chen, C.W., Kao, C.M., Chen C. F., Dong, C. D. (2007). Distribution and accumulation of heavy metals in sediments of Kaoshiung harbor. *Chemosphere*, **66,** 1431–1440.

Drira Z., Sahnoun H., Ayadi H. (2017). Spatial distribution and source identifcation of heavy metals in surface waters of three coastal areas of Tunisia. *Polish Journal of Environmental Studies*, **26** (3), 1057–1069.

Gianna Andrews, (2012). Plastics in the ocean affecting human health. https://serc.carleton.edu/NAGTWorkshops/health/case_studies/plastics.html.

Hamuna, B., Tanjung, R. H. P., Suwito, Maury, H. K. (2018). Study of seawater quality and pollution index based on physical-chemical parameters in Depapre District waters, Jayapura. *Jurnal Ilmu Lingkungan*, **16** (1), 35–43.

IAEA Bulletin 54. (2013, September 03).

Jilani, S., (2018). Present pollution profile of Karachi coastal waters. *J. Coast Conserv.*, **22**, 325–332. https://doi.org/10.1007/s11852-017-0581-x.

Mashiatullah, A., Qureshi R. M., Ahmad N., Khalid, F., Javed, T. (2009). Physico-chemical and biological water quality of Karachi coastal water. *The Nucleus*, **46** (1–2):53–59.

Mumtaz M. (2002). Geochemical studies of heavy metals in the seawater along Karachi Makran coast. Ph.D. Thesis, Dept. Chemistry, Univ. Karachi. 434 pp.

Nergis, Y., Sharif, M., Farooq, M. A., Hussain, A., Butt, J. A. (2012). Impact of industrial and sewage effluents on Karachi coastal water and sediment quality. Middle-East. *J. Sci. Res.*, **11 (**10), 1443–1454.

PAK-EPA, (2015). Pakistan Environment Protection Agency, present condition/level of pollution in Karachi harbour, (2015, November 11) Retrieved from www.environment.gov.pk.

Qadri, M., Nergis Y., Mughal N. A., Sharif M., Farooq M. A. (2011). Impact of marine pollution at Karachi coast in perspective of Lyari River. *American Eurasian J. Agri. & Env. Sci.*, **10** (5), 737–743.

Saleem, M. S., Kazi G. H. (1998). Concentration and distribution of heavy metals (lead, cadmium, copper, nickel and zinc) in Karachi shore and offshore sediments. *Pak J. Marine Sciences*, **7**, 71–79.

Saleem, M. S., Kazi G. H. (1995). Distribution of trace metals in the seawater and surficial sediments of the Karachi harbour. In: Thompson MF and. Tirmizi NM (Eds.), Proceedins of the Arabian Sea– Living Marine Resources and the Environment, Vanguard Books (Pvt.) Ltd., Lahore, Pakistan, 659–666 pages.

Sayied, N. (2007). Environmental issues in coastal waters – Pakistan as a case study. A MS dissertation submitted to the World Maritime University, Sweden.