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Study on Pollution Status of Sediment with Reference to its Physico-Chemical Properties along Industrial Creeks of Surat City, Gujarat

Alpa Varsani[1], Kapila Manoj[2]

Department of Aquatic Biology, Veer Narmad South Gujarat University, Surat

Abstract: ***The present study aimed to establish pollution status in sediment along with the Industrial creek of Surat city, Gujarat. The physico-chemical properties of the sediment of the creeks of Surat city were analysed. The samples were collected monthly from three different sites for the period of six months. In the present investigation, the pH, temperature, H_2S, chloride, nitrite, nitrate, phosphate and silicate were examined in sediment sample. Statistical analysis of the data is presented to find out the correlation among measured variables. The present study revealed depreciate condition of sediment of industrial creek which points out to the need of regular monitoring of water resources and further improvement in the industrial waste water treatment methods.***

Keywords: sediment, pollution, industrial creek, physico-chemical properties, Statistical correlation.

1. Introduction

Sediment is the loose sand, clay, silt and other soil particles that settle at the bottom of a body of water. Sediments are a major carrier phase for pollutants and provide useful spatial and temporal information [1-3]. Due to the many anthropogenic activities in industrial areas sediment may get polluted which may cause major contamination and which is more responsible for increasing the pollutants in the sediment. Municipal sewage water, industrial effluents and many unwanted wastes like plastic materials, bottles, broken pieces of metal etc. are also dump into the creek near by them. The pollutants are starting to get deposited on the soil when the soil gets accumulated by the toxic substances such as metals, trace elements and other organic substances from domestic and industrial sectors [4].

Sediments comprise an important component of aquatic ecosystems, providing habitat for a wide range of benthic and epi-benthic organisms. Exposure to certain substances in sediments represents a potentially significant hazard to the health of these organisms. Effective assessment of this hazard requires an understanding of the relationships between concentrations of sediment associated chemicals and the occurrence of adverse biological effects. Sediments are a sink as well as a source of contaminants in the aquatic environment. These contaminants may pose a high risk to the environment on a large scale and hence need to be monitored at regular intervals. The present study was conduct to gather data about the state of sediment quality in industrialized areas of Surat city and make recommendations based on finding for measures to prevent pollution by industries.

2. Literature Survey

Geographical location of Surat district is 21.0^{0} to 21.23^{0} N latitude and 72.38^{0} to 74.23^{0} E longitude. It is an industrial hub for the textile and diamond industries. Surat is a city which drains its storm drainage through Mithi, Kankara, Khajod, Koyali, Bhedwad, Sonari and Varachcha (creek) into Mindhola River. The Creek receives domestic raw sewage as well as industrial waste water effluent from surrounding habitation and nearby industrial belt. There are many creeks flow through Surat city from which three sites were selected viz. Creek-1 Bhedwad Khadi (Bamroli), Creek-2 Mithi Khadi (Udhana) and Creek-3 Saniya Hamed (Saroli) where domestic sewage and industrial effluent drained.

3. Methodology

The sediment was collected monthly from the selected sites for the period of six months (Oct-2012 to March-2013) by adaptive core sampling technique as described in Nybakken [5]. The sediment was scooped by pushing 50 cm long acrylic core of 5 cm diameter into soil of the creek. Collected samples were stored in polythene bags and brought to the laboratory for analysis.

The physico-chemical parameters selected for study are pH, Temperature, Chloride, H_2S, Silica, Phosphate, Nitrate and Nitrite. APHA [6] and IS-3025 [7] followed for the analysis. Statistical analysis was done with SPSS.

4. Results and Discussion

The physicochemical properties of sediment samples collected from different sampling station illustrated in Table-1. Table-2 shows correlation coefficient of various physicochemical parameters of sediment by Pearson Correlation technique. Descriptive Statistics were represented in Table-3.

Table 1: physicochemical properties of sediment samples collected from different sampling station

Month	Site	Temp. °C	pH	Chloride mg/kg	H_2S mg/kg	Nitrite mg/kg	Nitrate mg/kg	Phosphate %	Silicate mg/kg
Oct-12	1	30	7.79	1062	16.02	0.05	2.15	0.79	66.74
	2	27	7.39	559	12.23	22.95	25.70	0.83	74.54
	3	28	7.45	265	10.54	0.10	3.40	0.92	62.65
Nov-12	1	25	7.59	880	17.20	0.91	6.92	0.18	49.63
	2	24	7.43	891	ND	47.35	45.74	0.17	81.27
	3	24	7.16	409	ND	0.06	1.19	0.82	55.44
Dec-12	1	26	6.80	2056	15.29	0.08	10.46	0.98	125.62
	2	27	7.23	613	ND	0.07	8.23	0.75	40.98
	3	28	7.18	514	ND	0.05	6.79	0.69	41.69
Jan-13	1	27	6.92	3078	16.78	1.20	24.60	1.2	148.10
	2	28	7.30	310	ND	0.05	1.78	0.98	50.60
	3	27	7.49	218	ND	0.09	2.98	0.99	47.20
Feb-13	1	28	6.78	3102	14.98	2.34	14.69	1.45	169.23
	2	27	7.20	340	ND	0.83	1.28	0.78	140.70
	3	28	7.52	298	ND	1.90	3.49	0.75	96.45
Mar-13	1	30	9.05	1037	18.60	0.52	2.59	0.40	66.86
	2	31	8.26	706	ND	0.54	53.60	0.47	82.17
	3	32	7.55	483	ND	1.61	0.51	0.44	44.48

ND- Not Detected

Table 2: Correlation coefficient of various physicochemical parameters of sediment by Pearson Correlation

	pH	Temperature	Chloride	H2S	Nitrate	Nitrite	Slicate	Phosphate
pH	1							
Temperature	.501(*)	1						
Chloride	-.348	-.060	1					
H2S	.112	.018	.635(**)	1				
Nitrate	.092	-.062	.242	-.055	1			
Nitrite	-.029	-.402	-.031	-.112	.597(**)	1		
Slicate	-.393	-.099	.749(**)	.356	.232	.023	1	
Phosphate	-.592(**)	-.014	.492(*)	.180	-.230	-.374	.531(*)	1

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 3: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
pH	18	6.78	9.05	7.449	0.532
Temperature	18	24	32	27.611	2.173
Chloride	18	218	3102	934.500	895.925
H2S	18	0	18.6	6.758	7.959
Nitrate	18	0.51	53.6	12.006	15.669
Nitrite	18	0.049	47.35	4.483	11.937
Slicate	18	40.98	169.23	80.242	39.881
Phosphate	18	0.17	1.45	0.755	0.331

Temperature

Temperature was ranged from 25-30°C, 24-31°C and 24-32°C at site 1, site 2 and site 3 respectively. Temperature of sediment was influenced with the water temperature as well as atmospheric temperature at all sites.

pH

pH was ranged from 6.78-9.05, 7.20-8.26 and 7.16-7.55 at site 1, site 2 and site 3 respectively. pH shows strong positive correlation with temperature where as negative correlation of pH with chloride, phosphate and silicate shows solubility of minerals and nutrients is influenced by the pH.

The higher value of pH can also be attributed to increased production in aquatic ecosystem which utilize carbon and nitrogen from nitrates, and phosphorous, converting them into hydroxyl ions which increase the pH [8]. Changes in pH have direct bearing on the solubility of certain metals in aquatic environment [9]. The toxicity of heavy metals also gets enhanced at particular pH. Acidic sediments also mobilize metals that can be toxic to aquatic species [10]. Metal toxicity can cause reduced survivorship in fish through chronic stress, which impairs health and decreases the affected individuals' ability to secure food; shelter, or reproductive partners. Thus, pH is having primary importance in deciding the quality of sediments.

Chloride

Chloride was ranged from 880-3102 mg/kg, 310-891 mg/kg and 218-514 mg/kg at site 1, site 2 and site 3 respectively. Chloride is positively correlated with hydrogen sulphide, phosphate, silicate and nitrate which shows dissolution of many nutrients depends upon the chloride content hence plays an important role in cycle of nutrients and minerals.

High chloride concentrations are indicators of large amounts of organic matter in the soil and water. Source of chloride is sewage pollution and effluents from chemical industries and irrigation drainage to natural waters [11]. Chloride pollutants which are accumulated in sediment may get released in river water as a result of which their concentration in water may exceed the tolerable limit for inland surface water.

Hydrogen sulphide

Hydrogen sulphide was ranged from 14.98- 18.0 mg/kg, 12.23 mg/kg and 10.54 mg/kg at site 1, site 2 and site 3 respectively. Hydrogen sulphide shows negative correlation with nitrate and nitrite where as positive correlation with other parameters. It was increased with heavy organic load under conditions of decomposition at very low oxygen level. Mineralization of organic matter under anaerobic condition releases Hydrogen Sulphide [11]. Sulfide pollutants which are accumulated in sediment may get released in river water as a result of which concentration in water may be increased. The accumulation of sulfide led to highly toxic levels resulted in the disappearance of several sensitive species and a much lower total biomass. This toxicity effect was, however, more disastrous under nutrient-poor conditions, where almost all species disappeared completely.

Nutrients

Nitrite was ranged from 0.05-2.34 mg/kg, 0.05-47.35 mg/kg and 0.05-1.90 mg/kg at site 1, site 2 and site 3 respectively whereas Nitrate was ranged from 2.15-24.60 mg/kg, 1.28-53.60 mg/kg and 0.51-6.79 mg/kg at site 1, site 2 and site 3 respectively. Nitrate and nitrite are positively correlated with silicate but with phosphate shows negative correlation.

Phosphate was ranged from 0.18-1.45 %, 0.17-0.98 % and 0.44-0.99 % at site 1, site 2 and site 3 respectively. Silicate was ranged from 49.63-169.23 mg/kg, 40.98-140.70 mg/kg and 41.69-96.45 mg/kg at site 1, site 2 and site 3 respectively. Phosphate shows strong positive correlation with silicate.

Phosphorus pollution caused enormous blooms of the blue-green algae, a form of cyanobacteria, which can produce neurotoxins (affecting the nervous system) and hepatotoxins (affecting the liver). The same toxins can damage aquatic ecosystems, fisheries, and water quality. Excess amounts of phosphorus and nitrogen cause rapid growth of phytoplankton, creating dense populations, or blooms. It is important here to note that such high level of phosphate in sediments may get released in river water, as a result of which phosphate concentration may exceed the tolerable limit of inland surface water.

5. Conclusion

Statistical analysis of data shows correlation among different variables which shows that they are dependent to each other. The present data shows depreciate condition of sediment of industrial creek which points out to the need of regular monitoring of water resources and further improvement in the industrial waste water treatment methods. The existing situation if mishandled can cause irreparable ecological harm in the long-term well masked by short term economic prosperity. So there is the need to implement common objectives, compatible policies and programms for improvement in the industrial waste water treatment methods and its discharges.

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