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Research Article

ASSESSMENT OF WATER QUALITY INDEX AND HEAVY METAL CONCENTRATIONS AT SEA COAST INDUSTRIAL AREAS OF NELLORE IN THE BAY OF BENGAL COASTAL REGION OF INDIA

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ABSTRACT

In the recent years, the water quality of the different aquatic ecosystems has huge significance in the light of its job to human wellbeing, marine life, natural uprightness and feasible monetary development. Likewise, the persistent evaluation and observation of the water bodies are significant. This study was carried out for the assessment of the water quality index (WQI) at sea coast industrial areas of Nellore in the Bay of Bengal coastal region in India. WQI is utilized to assess the nature and quality of the specific water body. An endeavor was made without precedent for the province of Nellore coast to evaluate the effect of water quality in the coastal areas. A sum of nineteen water quality parameters were assessed from two different sampling sites (S1: Nelaturu and S2: Krishnapatnam) of Nellore coast for physico-chemical parameters. The estimations of WQI were observed in the sampling sites of S1 and S2 showing low quality of water, though low estimations of WQI were recorded in chosen sampling sites demonstrating reasonableness of those regions of human activities. In this way, water quality Index end up being a decent measure for sorting nature of seaside waters of Nellore coast.

Keywords: Water Quality Index, Nellore, Bay of Bengal, Coastal waters.

1. INTRODUCTION

The water quality affects the wealth of marine networks as the recreational utilization along the coastal areas. The monitoring programs of aquatic systems play a significant role in water quality management. However, the water quality is difficult to evaluate from a large number of samples, each contains varying concentrations of different water quality variables. The water quality index (WQI) is the most effective way to communicate the information on water quality trends in water quality management. The normal wellsprings of water like wells (open/tube wells) in towns are getting tainted by certain sources. For example, effluents from various industries, release of waste frameworks in natural water reservoirs, different human activities, domestic and municipal waste, washing from salt pans etc [1].

The current study was done to figure out the water quality index (WQI) so as to evaluate the nature of coastal waters along the sea coast industrial areas of the Nellore. In this study the detailed account on water quality and some aspects of pollution in Nellore coast was summarized consequent to the rapid industrialization and urbanization along the selected areas of the Nellore coast. The present study focuses on comparison of water quality at different coastal areas of Nellore through "Water Quality Index (WQI)". Salinity is one of the most significant issues of agrarian water system in parched and semi dry zones. Both water system and soil arrangement can expand salinity, which thus diminishes crop profitability and powers a move to progressively safe yields. Salinization of beach front new water springs via seawater interruption, geomorphic changes, tsunamis, cyclonic tempests and manmade perils are significant reasons for the ground water contamination in the seaside areas of the coast of the Bay of Bengal region. In the coast of Andhra Pradesh, salinization of fresh water aquifers is mainly due to indiscriminate utility of ground water, cyclonic storms and manmade pollution (through the aquaculture, agricultural practices, industrial effluents and sewage). This study aimed at identifying the quality of the water in the selected areas of the Nellore coast.

The rapid industrialization in coastal regions resulted in environmental pollution and higher quantities of heavy metals are being added into the natural estuarine and coastal environments. The heavy metal contamination in the coastal water has connections directly to the biota and indirectly to the human life. They will also cause irregularity in blood; badly affect the major functioning organs like kidneys and liver. Heavy metals including both essential and nonessential elements have a particular significance in eco-toxicology since they are highly persistent and all have the potential to be toxic to the living organisms. Heavy metals are considered as the foremost anthropogenic contaminants in coastal and marine environments in the worldwide [2].

2. MATERIAL AND METHODS

2.1. Study area

The Nellore region has 169 km of the coast line with home of angler's network along the east coast of India. The current study areas of Nelaturu (S1) and Krishnapatnam (S2) (Latitude: 14°15'16.5"N; Longitude: 80°6'33.69"E) seaside zones are significant angling places in Nellore coast and close by the inspecting locales which comprises of neighbourhood showcases in the town where the fishes caught from the sea coastal waters are regularly sold and near to the sampling sites have the thermal power industries and also shipping activities in the Krishnapatnam port area are regularly done from this coastal region.

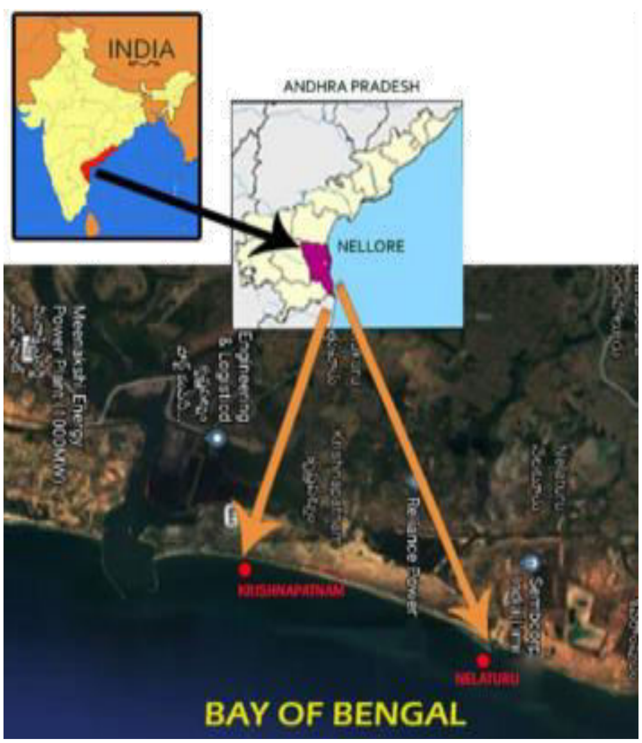

Fig. 1: Map showing the field stations in the present study area of Nellore coast

2.2. Water Sampling and physico-chemical analysis

The water samples were collected in pre-cleaned plastic polyethylene bottles for physico-chemical analysis during the period of winter season (December 2019 to February 2020). The coastal water samples were analyzed for temperature, pH, turbidity salinity, dissolved oxygen, biological oxygen demand, ammonia nitrogen, nitrites, nitrates, phosphates-phosphorus and heavy/trace metals (iron, copper, chromium, zinc, cadmium and lead) following standard procedures recommended by the APHA standard methods [3, 4].

2.3. Sample preparation for heavy metal analysis

The assimilation technique for water tests was done by moving a deliberate volume (50 mL) of all around blended corrosive safeguarded water test to a cone shaped cup then 5 mL of concentrated nitric corrosive (Conc. HNO_3) was included into the cup. The digestion procedure for water samples was carried out by transferring a measured volume (50 mL) of well-mixed acid preserved water sample to a conical flask. Then 5 mL of concentrated nitric acid (Conc. HNO_3) was added into the flask. The water sample and Nitric acid mixture were boiled and evaporated on a hot plate to the lowest volume of up to 10 to 20 ml. Continued the heating and adding conc. Nitric acid (HNO3) to the sample digestion was complete to show by a light color clear solution in the sample digestion conical flask. After that conical flask was washed down with distilled water and filtered. Then the filtrate was transferred into 10 mL volumetric flask with two 5ml of water, adding these rinsing to the volumetric flask and cooled and diluted to the mark and mixed thoroughly. A portion of the sample solution was taken for required metal determinations flowed by (APHA) [4].

2.4. Heavy metals examination through Atomic Absorption Spectroscopy (AAS)

The Atomic Absorption Spectroscopy (AAS) is most broadly utilizing a systematic method for in assurance of substantial metals upto parts per billion (ppb) levels. AAS is a valuable strategy to decide follow levels of multi-components in single desire. AA-6800 AAS combined with GFA-EX7 graphite heater atomizer and ASC-6100 auto sampler from Shimadzu (Koyoto, Japan) was utilized for substantial metal investigation. A high-thickness graphite tube was utilized for atomization.

Typical single empty cathode lights were utilized for illumination followed by APHA [4].

2.5. Estimation of Water quality index (WQI)

The computation of water quality index (WQI) was calculated by using WAWQI method followed by Horton's, by Calculate Water Quality Index (WQI) using formula in the last step, WQI= $\sum qn\ Wn/\sum Wn$. Water quality grades can be classified by excellent, good, poor, very poor and unsuitable with reference to the given in Table 2 [5, 6].

3. RESULTS AND DISCUSSION

The results obtained on water quality variables uncovered considerable contrasts between the beach front condition subject to contamination and the unaffected untamed ocean area. The mean values of analytical results of the physico-chemical parameters at different sampling sites at Nellore coast are given in Table 3. The traditional approaches to assess water quality are based on a comparison of experimentally determined parameter values with existing guidelines (Table 1).

Table 1: Standards and permissible limits of water quality parameters for coastal waters

Parameter	Prescribed Standards
Temperature	26-30 °C
pH	6.5 – 8.5
Turbidity	30 NTU
Salinity	>10
Total Suspended Solids	-
Dissolved Oxygen	4.0 mg/l or 50% saturation value
Biochemical Oxygen Demand	3 mg/lit
Ammonia- Nitrogen	0.021 mg/l
Nitrite Nitrogen	-
Nitrate Nitrogen	0.01-0.06 mg/l as Nitrate
Phosphate-Phosphorus	0.001 – 0.01 mg/lit as
Iron (Fe)	3mg/l
Copper (Cu)	0.5mg/l
Chromium (Cr)	0.05mg/l
Zinc (Zn)	0.5mg/l
Cadmium (Cd)	0.005 mg/l
Lead (Pb)	0.05mg/l

The sampling sites of Nelaturu and Krishnapatanam, the effects of pollution are relatively high, the waters are distinctly characterized by an overall range of Temperature (S1; 27.2±3.2, S2; 29.6±4.1°C), Salinity (S1; 29.8±6.8, S2; 31.9±8.3 °C), pH (S1; 7.6±1, S2; 7.7±0.9), Turbidity (S1: 44.5±4.1, S2: 46.3±3.4), Suspended solids (S1: 49.7±5.2, S2: 55.6±8.8), Dissolved oxygen (S1: 5.2±3.5, S2: 4.8±3.8), Biochemical Oxygen Demand (S1: 3.5±1.4, S2: 2.6±1.2), Ammonia Nitrogen (S1: 0.0 14±0.01, S2: 0.016±0.1), Nitrates (S1: 0.067±0.03, S2: 0.054±0.04), Nitrites (S1: 0.014±0.01, S2: 0.01±0.01), Phosphates (S1: 0.046±0.011, S2: 0.056±0.014), are set up from signify-cant physico-chemical parameters for during various months to comprehend the waterfront water quality better for the overall population (Table 3).

A lower value of WQI would indicate a better quality of water whereas high values indicate poor quality of the water. The calculated values of WQI for the studied physico-chemical parameters in this investigation were ranged from 50-100 for the sampling sites of Nelaturu and Krishnapatnam areas which indicate moderate water quality, coming to the trace metals levels selected areas water polluted due to heavy metals during the study period, where minimal human intervention was observed. In the selected sampling sites, the WQI values were recorded indicating contamination in the water due to presence of heavy metals [7]. It is because of the selected study areas observed through human interventions like fishing, shipping operations, industrialization and recreation activities.

Table 2: Grades of Water Quality Index (WQI) and status of Water Quality Rating

WQI	Category of Water Quality
<50	Excellent
50-100	Good
100-200	Poor
200-300	Very Poor
>300	Unsuitable

The scope of the substantial metals were available in the seaside water of Nelaturu(S1) and Krishnapatnam(S2) beach front areas of Nellore coast in the present study done through AAS analysis. In spite of the fact that, there was no way that the substantial metal thickness is much more time taken to be as the characterizing factor. Most part of the metals are overwhelming and are characterized by having a particular thickness in excess of 5 g/cm^3. Substantial metals are the most widely recognized ecological contaminations and their events in water and biota shows the nearness of common or anthropogenic sources. The primary dangers to human wellbeing from substantial metals are related with presentation to lead (Pb), cadmium (Cd) and mercury (Hg). Their accumulation and distribution in soil, sediments and aquatic environment are increasing at an alarming rate thereby affecting marine life [8-10].

Table 3: Mean ± SD values of various water quality parameters and WQI at different sampling sites (S1 & S2) of Nellore coast

Parameters	S1 (Nelaturu)	WQI	S2 (Krishnapatnam)	WQI
Temperature (°C)	27.2±3.2	13	29.6±4.1	10
Salinity (ppt)	29.8±6.8	8	31.9±8.3	7
pH	7.6±1	92	7.7±0.9	91
Turbidity	44.5±4.1	42	46.3±3.4	41
Suspended Solids	49.7±5.2	86	55.6±8.8	87
Dissolved Oxygen (mg/L)	5.2±3.5	5	4.8±3.8	4
Biochemical Oxygen Demand	3.5±1.4	64	2.6±1.2	69
Ammonia- Nitrogen	0.014±0.01	97	0.016±0.1	97
Nitrates (mg/L)	0.067±0.03	97	0.054±0.04	97
Nitrites (mg/L)	0.014±0.01	97	0.01±0.01	97
Phosphates	0.046±0.011	98	0.056±0.014	98
Average		**63.54**		**63.45**

Table 4: Mean values of heavy metal concentrations in sampling sites (S1 & S2) of Nellore Coast

Heavy Metal	S1 (Nelaturu)	S2 (Krishnapatnam)
Arsenic (mg/ L)	1.6±0.01	1.8±0.02
Cadmium (mg/ L)	3.1±0.03	3.6±0.04
Chromium(mg/ L)	0.24±0.01	0.28±0.03
Copper(mg/ L)	0.03±0.01	0.09±0.01
Iron(mg/ L)	1.2±0.010	1.4±0.012
Lead(mg/ L)	3.8±0.04	4.2±0.02
Zinc(mg/ L)	0.02±0.01	0.04±0.01

Arsenic (As) concentrations were observed 1.6±0.01 mg/L in Nelaturu(S1) beach, 1.8±0.02mg/L in Krishnapatnam (S2) coast. The high concentrations were observed in both areas (Table 4). The permissible limit for arsenic as per the WHO is 0.01 mg/L. However, the observed concentration levels of Arsenic in the study area were observed as excess than acceptable limits given by the WHO guidelines. Long-lasting presence of arsenic in drinking water can cause malignancy in the skin, lungs, bladder, and kidney. It can also cause other skin changes such as thickening and pigmentation [11].

Cadmium (Cd) concentrations were observed 3.1±0.03 mg/L in Nelaturu (S1), 3.6±0.04 mg/L in Krishnapatnam (S2) coast whereas the maximum concentrations were observed in both study areas (Table:4). The permissible limit for cadmium is as per WHO 0.003 mg/L. Cadmium is broadly circulated in the world's outside and is essentially utilized in numerous enterprises and in agribusiness, as per United States Public Health norms. Higher values of Cd in waste water effluent samples suggest the high level of pollution due to dyes paints and pigments manufacturing industries [12]. Cadmium (Cd) targets the liver, placenta, kidneys, lungs, brain, and bones. Consumption of food or drinking water with very high cadmium levels severely irritates the stomach, leading to vomiting and diarrhea and sometimes causes death [13].

Chromium (Cr) concentrations were observed 0.24± 0.01 mg/L in Nelaturu, 0.28±0.03 mg/L in Krishnapatnam (Table 4). The hypersensitive response of chromium incorporates extreme redness and growth of the skin. Exposure of extremely high doses of chromium (VI) compounds to humans can result in severe cardiovascular, respiratory, hematological, gastrointestinal, renal, hepatic, and neurological effects and possibly death [14].

Copper (Cu) focuses were watched 0.03±0.01 mg/L in Nelaturu (S1), 0.09±0.01 mg/L in Krishnapatnam (S2) coast (Table 4). It is within the permissible level as prescribed by the WHO guidelines at Nelaturu. Copper is one of the basic metals to life not withstanding being as inalienably harmful as unimportant substantial metal exemplified by lead and mercury. Plants and creatures quickly amass it. It is poisonous at minute low focus in water and is known to cause cerebrum harm in warm blooded animals. The normal contributions of copper to the marine amphibian condition are from disintegration of mineralized rocks or perhaps from the chemical industries. Anthropogenic contributions of copper from enterprises and paints. It likewise frames buildings with natural particles. Mollusks have a gigantic ability to collect copper from polluted water [15].

Iron (Fe) concentrations were observed 1.2±0.010 mg/L in Nelaturu(S1), 1.4±0.012 mg/L in Krishna-patnam (S2) coast(Table:4). The maximum acceptable limit for iron as per IS: 10500 is 0.3 mg/L and no guideline value was given by the WHO for Iron content. However, the observed concentration levels of Iron found within the permissible given by WHO [15].

Lead (Pb) concentrations were observed 3.8±0.04 mg/L in Nelaturu (S1), 4.2±0.02 mg/L in Krishnapatnam (S2) coast (Table 4). The maximum concentrations were observed in both study areas. The permissible limit for Lead is as per IS: 10500 is 0.01 mg/L. Lead may be a highly toxic metal substance, exposure to which may produce high range of adverse health effects in human beings. Every year, industries producing about 2.5 million tons of lead throughout the world that used for making batteries. In adults, lead can increase blood pressure and cause infertility problems, nerve disorders, muscle and joint pain, irritability and memory or concentration problems may appear [16, 17].

Zinc (Zn) concentrations were observed 0.02±0.01 mg/L in Nelaturu (S1), 0.04±0.01 mg/L in Krishnapatnam (S2) coast (Table 4). It is within the permissible limits at Nelaturu and Krishnapatnam given by IS: 10500 and WHO guidelines. Zinc is an essential nutrient for the human body and has importance for health also it acts as a catalytic or structural component in many enzymes that are involved in energy metabolism also. Symptoms of zinc toxicity are slow reflexes, tremors, paralyzation of extremities, anemia, metabolic disorder, teratogenicity effects and increased mortality [15].

4. SUMMARY AND CONCLUSIONS

On the basis of the examined different parameters in this investigation, it can be concluded that the coastal water quality at sampling stations, in Nelaturu (S1) and Krishnapatnam (S2) of the Nellore coast area was polluted and was within coastal water standards in particular. The same results can be attributed from WQI values calculated from selected water quality parameters. Thus, the 'Water Quality Index' proved to be a useful measure for the analysis and categorization of the quality of coastal waters of Nellore region.

In the present study, the heavy metals of copper and zinc concentrations in the seawater have been observed in <1.0 mg/L. The increased toxic heavy metal concentrations in the water leads to the bioaccumulation factors in the aquatic food chain and it showed the transfer of metals especially arsenic, lead, cadmium, mercury are warning signal for fish consumption by humans towards food safety.

The water quality parameters of the selected coastal area of Nelaturu and Krishnapatnam can be affected by the toxicity of the metal either by influencing the physiology of organisms or by altering the chemical form of the metal in water. The increased ambient heavy metal concentration will result in accumulation in the tissues of commercially important edible finfish and shell fish. It is an inherent danger of higher bioaccumulation of toxins in the edible species that may result in severe health hazards to the consumers especially humans. It was evident that the present study on heavy metals in the water of the Nellore coast suggested adopting effective heavy metal removal technologies to control the toxic metal contamination in coastal water. Further bioaccumulation study to be needed for better understanding of the metal toxicity in the coastal and marine environment.

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