IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 1, January 2016.
www.ijiset.com
ISSN 2348 – 7968

Monitoring water quality of surface water bodies from CRZ-I: A case study at Dakshin Purusotyampur and Dadanpatrabar villages, Contai coastal plain, West Bengal, India.

[1]Amrit Kamila, [2]Ashis Kr. Paul and [1]Jatisankar Bandyopadhyay

[1]Department of Remote Sensing & GIS, Vidyasagar University, Midnapore-721102

[2]Department of Geography & E.M., Vidyasagar University, Midnapore-721102

Email ID: *kamila.amrit90@gmail.com*

Abstract

Water quality monitoring in surface water bodies of the coastal region is playing a major role in water quality monitoring programme. This is mostly due to the insufficiency of traditional method forced by the lack of comprehensive and reliable datasets. In this study it has explored the possibility of ground truth data to quantify pollutant indicators through the estimation of water quality parameters of the study area. As per the person's perception the water quality of surface water bodies (such as dune ponds and wetlands) has been dilapidated in the areas of CRZ-I, the measurement and identification of water quality status are necessary in the sensitive environmental components of low lying coasts. Owing to the complexity associated with field collection data of water quality samples and subsequent analysis, the present methods have been utilized for exploration of water quality information of the present study area with the use of water analyzer (WQC 24) instrument. The present work is conducted on inland areas and in the areas of sea shores and back water fringes. Some areas of Dakshin Purusotyampur, Dadanpatrabar and Mandarmoni villages of Contai Coastal Plain have been considered for the present study. The paper aims to create and analyze the different parameters of surface water quality for generating the database in Geographical Information System (GIS). The pH, Dissolved Oxygen (DO), Conductivity, Turbidity, Temperature, Salinity and Chlorophyll Concentration are considered for monitoring the surface water and for mapping the data base of the CRZ-I.

Key Words: *Water quality monitoring programme, Pollutant indicators, pH, DO, Conductivity, Turbidity, Temperature, Salinity and Chlorophyll Concentration.*

1. Introduction

Water quality is a general descriptor of water properties in terms of physical, chemical, thermal, and biological characteristics. General perception of water quality is that the water is polluted or not. It is measured the condition of water, the assess water quality relates to the health of ecosystems, safety of human contact and drinking water. In fact water quality is combined subject, because water is inherently attached to the ecology of the earth. Generally, industrial and commercial activities (e.g. Manufacturing, mining, construction and transport) are the main source of water pollution that effluence the runoff from agricultural areas, urban runoff and discharge of treated and untreated sewage. Water quality is affected by materials transport to the water body from either point or nonpoint sources. Point sources can be traced to a single source, such as a pipe or a ditch. Nonpoint sources are dispersed and associated with the landscape and its response to water movement, land use and management, salt water fluctuations and other human and natural activities in this region. Polluting materials lead to collapse the quality of water which is more effective to the freshwater and estuarine ecosystems in the world [1]. Monitoring and assessing the quality of surface waters is a critical task of managing and improving its quality. In situ measurements and collection of water samples data and consequent laboratory analyses are currently used to appraise the water quality.

2. Methodology

Water samples are collected from the field with the help of Water Analyzer Instrument. The monitoring programme is directly related to the sampling frequency. The sampling frequency can be described by the total number of collecting field samples. These quantitative samples are incorporated in support of sampling frequency approach through some standard statistical operations. The sampling frequency fluctuates substantially depending on the purpose of the monitoring programme and the variables to be measured. These individual measuring variables are deliberated through some empirical methods to enumerate the samples. In this intentional monitoring programme, the common samples are generally taken through the observation propensity of the variables.

The methods are able to describe the direct monitoring activities, i.e. the set-up of sampling networks, variables to be measured, sampling frequency, data storage and information utilization, including data analysis and reporting.

3. Study Area

The study area is situated on the Dakshin Purusotyampur and Dadanpatrabar villages in the Contai Coastal Plain; specifically these two villages are placed in the Mandermoni coastal belt, Purba Medinipur, West Bengal, India. The water samples are collected between latitude: 21°40’20’’N to 21°41'03"N and longitude 87°42'48"E to 87°44‘51"E respectively.

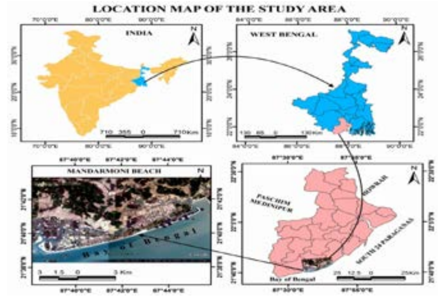

Figure 1: Location map of the study area

Table 1: Water quality parameter monitored in the coastal belt of Mandermoni & Dakshin Purusotyampur village

Sample No.	Places	Longitude	Latitude	Time	Date	Depth.	PH	DO	Cond.	Turb.	Temp.C	Salt	Chlo.
Sample -1	Sea face nearby Soula river mouth	87°44'47.98"E	21°40'51.39"N	9:30AM	8/15/2014	1Ft.	8.39	7	0.63	54.1	29.3	4.2	17.7
Sample -2	Back water areas	87°44'44.16"E	21°40'58.65"N	9:35AM	8/15/2014	10Inch	7.87	2.85	0.35	5.1	29.5	1.8	9.9
Sample -3	Back water areas	87°44'44.70"E	21°40'58.70"N	9:37AM	8/15/2014	1Ft.	7.7	2.66	0.89	6.5	29.8	5.2	8.6
Sample -4	Back water areas	87°44'43.12"E	21°40'59.13"N	9:40AM	8/15/2014	1.5Ft.	8.3	4.63	0.59	7.3	29	3.3	7.8
Sample -5	Soula river mouth	87°45'26.88"E	21°41'23.09"N	9:59AM	8/15/2014	1.5Ft.	7.8	4.9	0.21	267	30.2	0.4	14.9
Sample -6	Soula river mouth	87°45'26.88"E	21°41'23.03"N	10:02AM	8/15/2014	2Ft.	7.49	4.33	0.29	262.6	30.2	0.6	13.6
Sample -7	Abundant dune pond	87°44'30.60"E	21°40'48.47"N	12:01N	8/15/2014	2Ft.	9.31	7	9.9	3.4	30.8	0	13.8
Sample -8	Near shore water	87°44'04.19"E	21°40'31.76"N	12:30PM	8/15/2014	1.5Ft.	8.32	6.92	1.35	259.1	28.8	19.7	0
Sample -9	Dune pond	87°44'01.91"E	21°40'34.95"N	12:38PM	8/15/2014	2Ft.	8.52	7.39	0.19	471.5	30.4	0.7	20.1
Sample -10	Village pond	87°44'01.57"E	21°40'36.62"N	12:43PM	8/15/2014	1Ft.	9.71	8.06	0.142	3	30.9	0.7	8.8
Sample -11	Village pond	87°43'59.69"E	21°40'37.09"N	12:47PM	8/15/2014	10Inch	10.14	6.9	0.15	1.2	31.9	0.7	7.3
Sample -12	Village pond	87°43'57.05"E	21°40'39.10"N	12:56PM	8/15/2014	2Ft.	9.36	6.97	74.6	9.6	30.7	0.3	12.5
Sample -13	Tidal channel	87°44'02.71"E	21°40'46.57"N	01:08PM	8/15/2014	3Ft.	7.93	4.76	0.35	109.4	30.6	1.7	13.5
Sample -14	Back water areas	87°43'15.86"E	21°40'08.64"N	11:30AM	8/16/2014	1Ft.	7.6	5.65	1.5	24.2	30.2	9	10.2
Sample -15	Dune pond	87°44'18.53"E	21°40'09.55"N	11:35AM	8/16/2014	1.5Ft.	7.71	5.68	1.86	30.1	30.4	11.6	33
Sample -16	Village pond	87°43'25.66"E	21°41'11.26"N	11:42AM	8/16/2014	2Ft.	8.2	6.66	3.27	85.2	30.3	21.4	6.5
Sample -17	Village pond	87°44'31.32"E	21°40'14.29"N	11:50AM	8/16/2014	2Ft.	8.29	6.64	3.42	78.8	30.1	21.1	5.4
Sample -18	Back water areas	87°43'32.73"E	21°40‘52.78"N	11:55AM	8/16/2014	2Ft.	8.33	6.63	3.3	69.5	31	21.8	4.3
Sample -19	Village pond	87°43'35.02"E	21°39‘36.96"N	11:58AM	8/16/2014	4Ft.	8.33	6.63	3.3	69.5	31	21.8	4.3
Sample -20	Near shore water of Mandermoni	87°42‘49.61"E	21°41'00.21"N	02:10PM	8/16/2014	3Ft.	8.02	6.69	3.36	45.3	29.9	16.8	4.3
Sample -21	Village pond	87°43'43.05"E	21°40'30.07"N	10:00AM	8/17/2014	1.5Ft.	8.92	2.54	0.37	3.8	29.8	1.9	14.4
Sample -22	Village pond	87°43'44.06"E	21°40'28.08"N	10:10AM	8/17/2014	1Ft.	8.914	7.84	0.95	12	30.4	5.4	30.7
Sample -23	Village pond	87°43'75.00"E	21°40'45.00"N	10:17AM	8/17/2014	2.5Ft.	8.3	4.25	0.25	5.5	29.6	1.4	19.6
Sample -24	Near shore water	87°43'50.00"E	21°40'22.60"N	10:30AM	8/17/2014	2.5Ft.	8.45	6.88	2.9	915.2	29.9	18.6	1.9
Sample -25	Dune pond	87°43'30.00"E	21°40'21.20"N	10:45AM	1/6/1900	2Ft.	8.25	7.78	0.699	20.6	30.5	3.9	26.5
Sample -26	Fresh water Pond , Bengal Salt Factory	87°42'18.28"E	21°40'23.07"N	11:44AM	8/17/2014	2Ft.	8.34	5.47	35.7	12.3	30.1	0.1	6.2
Sample -27	Tidal creek	87°42'18.50"E	21°40'29.00"N	12:02PM	8/17/2014	1Ft.	8.18	5.17	0.721	123.4	31	4.1	13.5
Sample -28	Village pond near Salt pan	87°42'19.20"E	21°40'29.80"N	15:05PM	8/17/2014	2Ft.	8.49	6.47	1.21	64.9	29.2	7.1	8.6

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 1, January 2016.
www.ijiset.com
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4. Water samples point

Water samples were collected from Dakshin Purusotyampur and Dadanpatrabar villages, under the CRZ-I at the Mandermoni coastal belt. The area is enclosed of the sandy shores and back water fringes of Mandermoni dunes. The sample points were collected from different sites such as, dune pond, village pond, tidal creek, wetland, back water, fresh water, salt pan, abandoned dune pond, river mouth, near shore water and tidal channel.

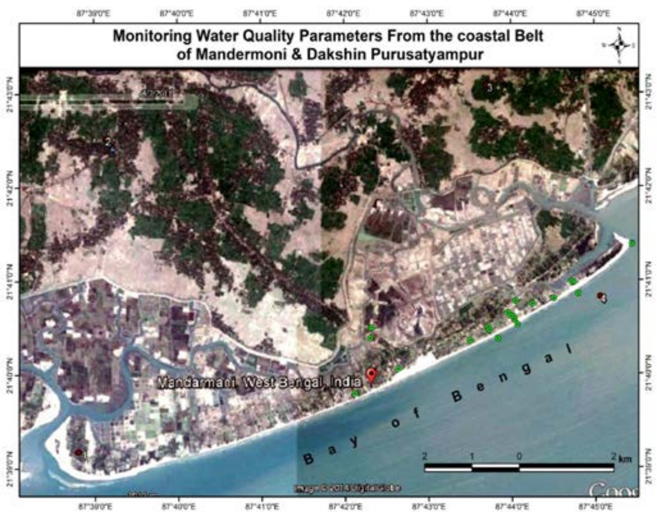

Figure 2: Position of the water sample points

5. Result and discussion

5.1 P^H

The P^H is a determined value based on a defined scale, it has oscillated scale between 0 and 14 defining and how acidic or basic a body of water is along a logarithmic scale [2]. The logarithmic scale means that each number below 7 is 10 times more acidic than the previous number when counting down.

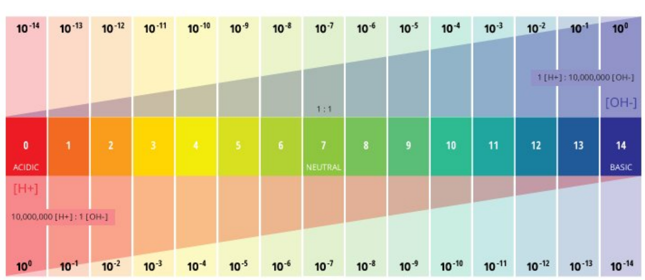

Figure 3: Range of pH scale

Likewise, when counting up above 7, each number is 10 times more basic than the previous number. This determination is due to the effect of hydrogen ions (H+) and hydroxyl ions (OH-) on pH. The higher the H+ concentration lowers the pH and the higher the OH- concentration higher the pH. At a neutral pH of 7 (pure water), the concentration of both H+ ions and OH- ions are 10^{-7} M [3]. Thus the ions H+ and OH- are always paired – as the concentration of one increases, the other will decrease; regardless of pH, the sum of the ions will always equal to 10^{-14} M². Due to this influence, H+ and OH- are related to the basic definitions of acids and Bases.

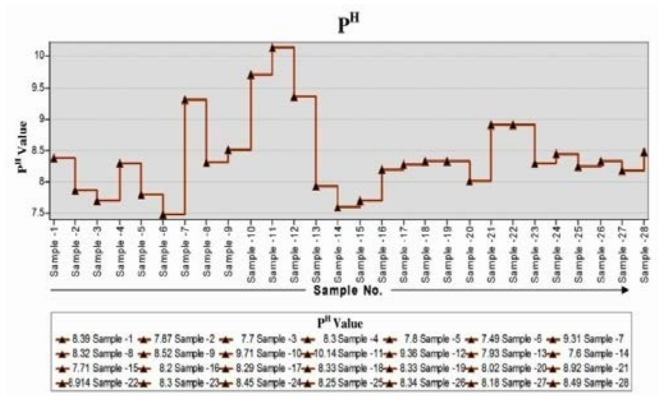

Figure 4: pH Diagram

Likewise, when counting up above 7, each number is 10 times more basic than the previous number. This determination is due to the effect of hydrogen ions (H+) and hydroxyl ions (OH-) on pH. The higher the H+ concentration lowers the pH and the higher the OH- concentration higher the pH. At a neutral pH of 7 (pure water), the concentration of both H+ ions and OH- ions are 10^{-7} M [3]. Thus the ions H+ and OH- are always paired – as the concentration of one increases, the other will decrease; regardless of pH, the sum of the ions will always equal to 10^{-14} M². Due to this influence, H+ and OH- are related to the basic definitions of acids and Bases.

The pH also controls the aquatic element; if the pH of water is too high or too low, the aquatic organisms living within it will die. The pH can also influence the solubility and toxicity of chemicals and heavy metals in the water [4]. Aquatic creatures favor the range of pH 6.5-9.0, though some can live in water with pH levels outside of this range. As pH levels travel from this range (up or down) it can generate anxiety to the animal systems that shrink the survival rates. The ancillary sensitive species are mostly affected by the changes of pH level. In the accumulation of biological possessions, severe pH levels typically enhanced the solubility of elements and compounds, building toxic chemicals, extra “movable” and increase the risk of absorption by aquatic life [5].

Seawater considers the pH range in between 7.5 to 8.5 depending on its local salinity. The levels of pH will amplify with salinity until the water reaches calcium carbonate ($CaCO_3$) saturation [6]. The pH level varies in between 7.5 to 10.14 in the study area because of the salt water encroachment. In generally the ocean waters hold high alkalinity owing to the carbon content and for this status oceans have a superior ability to barrier free hydrogen ions [7].

5.2 Dissolve Oxygen

Dissolve oxygen (DO) is a very imperative factor in assessing water quality for the reason that of its manipulation on the organisms alive contained by a body of water. In Limnology (the study of lakes), dissolved oxygen is an indispensable problem of water superiority. In that case the dissolved oxygen intensity that is excessively high or as well as low be able to damage aquatic life and distress water quality. Generally dissolved oxygen appears from the atmosphere and it can come out from photosynthesis by aquatic plants. It is evacuated throughout the chemical oxidation and respiration by aquatic animals and microorganisms, particularly for the period of the deterioration of plant biomass and additional untreated objects. The fishes of Saltwater and organisms have a superior acceptance for stumpy dissolved oxygen deliberations as well as saltwater has a low air diffusion than fresh water. In common aspect dissolved oxygen intensity is containing 20% less in sea water than in fresh water [8]. In This sense that doesn't mean that saltwater fish can live without dissolved oxygen completely.

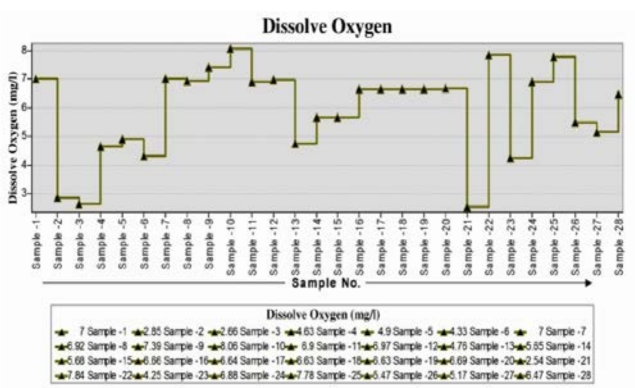

Figure 5: Dissolved oxygen Diagram

Dissolved oxygen is a necessary element in anticipation for a vigorous aquatic ecosystem. Basically fish and aquatic animals require the oxygen, which is dissolved in the water. Some of the organisms are tailored to lower oxygen circumstances while other's concentration of requirements is high. In this segment, the supplied oxygen depends on the stages of life and species. So dissolved oxygen is able to influence the solubility and accessibility of nutrients, which can be unrestricted from sediments beneath situation of low dissolved oxygen.

If the attentiveness of dissolved oxygen slump below an assured level, the rate of fish mortality will increase. Because susceptible freshwater fish like salmon can't flush replicate at levels below 6 mg/L [9]. In the coastal region, coastal fish instigated to stay away from the areas where DO is below 3.7 mg/L; however, in the midst of specific species deserting the area entirely when the levels of DO collapse below 3.5 mg/L [10].

5.3 Electrical Conductivity

The electrical conductivity of the water stretches out on the water temperature variabilities; the electrical conductivity would be higher in the high temperature. The electrical conductivity of water is enhanced by 2-3% for an improvement of 1 degree Celsius of water temperature. Numerous EC Meters now a day automatically has standardized the readings to 25^{o}C [11].

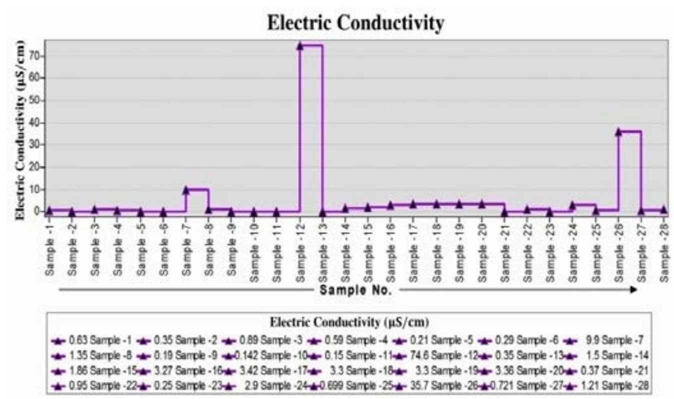

Figure 6: Electrical Conductivity Diagram

While the electrical conductivity is an ideal significance of the total salinity, it still does not afford any information regarding the ion composition in the water. The similar electrical conductivity values can be measured in low quality water (e.g. Water rich with Sodium, Boron and Fluorides) as well as in high quality irrigation water (e.g. Adequately fertilized water with appropriate nutrient concentrations and ratios)

5.4 Turbidity

Turbidity is the determination of water transparency, that contains how much the material suspended in water. Suspended materials consist of soil particles (clay, silt, and sand), algae, plankton, microbes, and other material. These supplied material sizes are typically varied in between the range of 0.004 mm (clay) to 1.0 mm (sand). On the other hand turbidity can influence the color of the water [12].

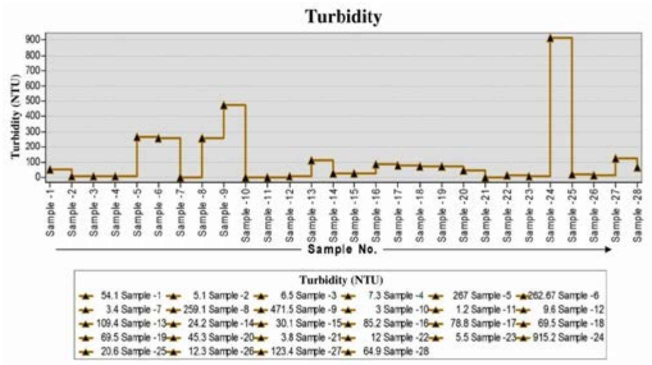

Figure 7: Turbidity Diagram

Higher turbidity increases water temperature because suspended particles absorb more heat. The concentration of dissolved oxygen (DO) decreases because of hot water holds less DO than cold water [13]. Higher turbidity also diminishes the amount of light penetration in the water, which is in another way reducing the photosynthesis and the production of the DO. Suspended materials can block fish gills, reducing resistance to disease in fish, lowering intensification rates, and affecting egg and larval development. Sources of turbidity include:

- Soil erosion
- Waste discharge
- Urban runoff
- Eroding stream banks
- Large numbers of bottom feeders (such as carp), which stir up bottom sediments
- Excessive algal growth.

5.5 Temperature

Water temperature is the degree of hotness or coldness of water (or the kinetic energy). Unnatural changes in water temperature can advocate the indicator of water quality in the (ANZECC & ARMCANZ) guidelines [14]. Water temperature is also probably the most important factor influencing viral persistence in estuarine environments.

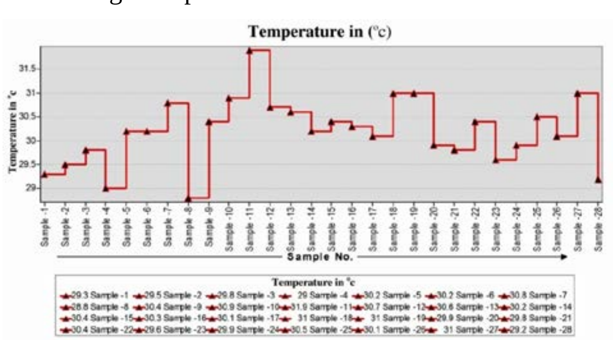

Figure 8: Temperature Diagram

Water temperature regulates ecosystem and carrying out the direct physiological effects on organisms, and indirectly, as a consequence of habitat loss. Changes of water temperature can affect the Photosynthesis, aerobic respiration, growth, reproduction, metabolism and the mobility of organisms which are important parameters of the coastal environment. When the 10^o C temperature increases the rates of biochemical reactions usually become double within the given tolerance range of an organism. When the temperature is increased the solubility of oxygen and other gases will decrease [15]. In this approach the cold water conserves more dissolved oxygen than warmer waters. Subsequently, the warm water cannot hold sufficient oxygen where the aquatic organisms can survive simply [16].

Water temperature influences the concentration of conductivity and pH of a water column. In addition, solubility of gases (e.g. Dissolved oxygen and carbon dioxide) decreases with increasing temperature (solubility being the maximum amount of gas that can be dissolved in a given volume of water). Water is more probable to become anoxic or hypoxic of under warmer conditions, because of increasing bacterial respiration and decreasing dissolved oxygen holding capability of water [17].

5.6 Salinity

Salinity is the content of salts in soil or water. Salts particles are extremely soluble in surface and groundwater and that can be transported with water movement. Salinity is a significant issue in coastal regions. The natural allotment of salt in a coastal landscape is referred to as ‘primary salinity’. Excessive amounts of dissolved salt in water can affect drinking water supplies and ecosystem health.

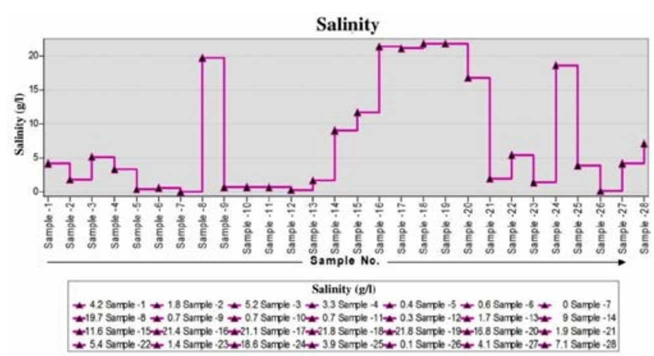

Figure 9: Salinity Diagram

Salinity is the content of salts in soil or water. Salts particles are extremely soluble in surface and groundwater and that can be transported with water movement. Salinity is a significant issue in coastal regions. The natural allotment of salt in a coastal landscape is referred to as

ISSN 2348 – 7968

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In normal circumstances, the deep roots of native plants absorb most water entering the soil before it reaches the salt contained in groundwater below the plant root zone [18]. However, widespread vegetation clearance, poor land use, irrigation and industrial practices have made it easier for salt to be transported to the soil surface from waterways. The additional salt from these altered land use and management practices is referred to as 'secondary salinity'.

The most significant off-site impact of dry land salinity was the Salinisation in the part of fresh channel. That can affect the quality of drinking water, irrigation with severe economic, social and environmental consequences for both rural and urban communities. High levels of salt may affect the taste of drinking water. Chloride in particular has a low taste threshold. Sodium and magnesium sulfate levels in drinking water may produce a laxative effect and reduce the suitability of a water supply for grazing animals. High levels of salinity in water and soil may cause an unhealthy situation for inhabitant vegetation that can die and lead to a decline in biodiversity through dominance of salt-resistant species, potentially altering ecosystem structures.

5.7 Chlorophyll concentration

Chlorophyll a is a green pigment found in plants. It absorbs sunlight and converts it to sugar during photosynthesis. Chlorophyll a concentration is an indicator of phytoplankton abundance and biomass, abundance in coastal and estuarine waters. High level chlorophyll contains regularly indicate poor water quality, and low levels often suggest good conditions [19].

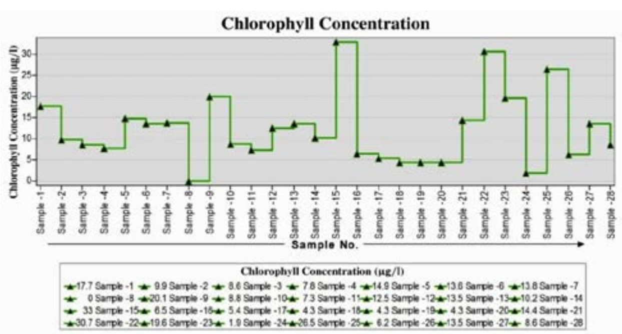

Figure 10: Chlorophyll concentration Diagram

It is expected that the chlorophyll levels can fluctuate over time. Chlorophyll concentrations are habitually privileged after rainfall, particularly if the rain has glowing nutrients into the water.Tidal regime is an important pressure on algal biomass. Strong tidal mixing contain lowers chlorophyll concentrations because the habitation time of algae in the photic zone is reduced. Tidal mixing also can causes fine sediment to resuspend and to elevate the turbidity levels that result, reduces the amount of light penetration limit for photosynthesis [20]. The slow moving water or stagnant waters control the nutrient level that can grow the numbers of planktonic cell. Superior concentrations of chlorophyll can reflect an increase in nutrient loads and the increasing trend can indicate the eutrophication of aquatic ecosystems.

5.8 Correlation matrix

All the water sample data are substantially loaded in GIS environment in the format of Relational Data Base Management System (RDBMS) for the better treatment of data. Each of these parameters has individual units on the basis of their uniqueness. First and foremost, all parameters are to be converted in z-score value for reducing the unit's status of the parameters with the help of statistical operations. Then all parameters renovate into an individual's numerous variable. These variables are calculated in the matrix of correlation algorithm for identifying which parameters have a significant role to maintain the best quality of water on the basis of standard score. According to the standard score each parameter (physically and chemically) acting an important role on the basis of correlation matrix between their personalities to indicate the quality of water.

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Table 2: Calculate the correlation matrix table to generate the standard value

Sample No.	Z-Score (PH)	Z-Score (DO)	Z-Score (Cond.)	Z-Score (Turb.)	Z-Score (Temp)	Z-Score (Salt.)	Z-Score (Chlo.)	Mean (Z-Score)	Standard Score
Sample -1	-0.0138711	0.70600683	-0.31812496	-0.27885555	-1.2984173	-0.38781437	0.69105015	-0.12857520	0.512102834
Sample -2	-0.8415903	-1.97059983	-0.33662554	-0.53301740	-1.0087306	-0.68497659	-0.2659907	-0.80593301	-0.45059983
Sample -3	-1.1121908	-2.09314327	-0.30094586	-0.52575563	-0.5742005	-0.26399678	-0.4254975	-0.75653292	-0.21314327
Sample -4	-0.1571302	-0.82256131	-0.32076790	-0.52160605	-1.7329475	-0.49925020	-0.5236556	-0.65398840	-0.82256131
Sample -5	-0.9530140	-0.64842063	-0.34587583	0.82545172	0.00517297	-0.85832121	0.34749700	-0.23250143	0.648420637
Sample -6	-1.4464620	-1.01605095	-0.34058995	0.80262902	0.00517297	-0.83355769	0.18799018	-0.37726692	-1.01605095
Sample -7	1.45055516	0.70600683	0.29437626	-0.54183526	0.87423322	-0.90784825	0.21252969	0.29828823	0.706006839
Sample -8	-0.1252948	0.65440960	-0.27055205	0.78447460	-2.0226342	1.53135825	-1.4806965	-0.13270503	-0.55440960
Sample -9	0.19305868	0.95754337	-0.34719730	1.88618839	0.29485972	-0.82117593	0.98552428	0.44982874	0.215754337
Sample -10	2.08726224	1.38967023	-0.35036883	-0.54391005	1.0190766	-0.82117593	-0.4009580	0.33994231	0.789670231
Sample -11	2.77172235	0.64151029	-0.34984024	-0.55324660	2.46751034	-0.82117593	-0.5850044	0.51021082	0.641510292
Sample -12	1.53014355	0.68665787	4.56933095	-0.50967600	0.72938985	-0.87070297	0.05302287	0.88402373	0.786657875
Sample -13	-0.7460842	-0.73871580	-0.33662554	0.00798423	0.58454647	-0.69735835	0.17572042	-0.25007611	0.538715802
Sample -14	-1.2713676	-0.16469653	-0.26064103	-0.43394615	0.00517297	0.20651005	-0.2291810	-0.30687854	-0.16469653
Sample -15	-1.0962731	-0.14534757	-0.23685457	-0.40334299	0.29485972	0.52843578	2.56832272	0.21568570	-0.14534757
Sample -16	-0.3163069	0.48671858	-0.14369095	-0.11754059	0.15001635	1.74184815	-0.6831624	0.15969744	0.486718581
Sample -17	-0.1730478	0.47381927	-0.13377993	-0.15073723	-0.1396703	1.70470287	-0.8181297	0.10902241	0.273819272
Sample -18	-0.1093771	0.46736961	-0.14170875	-0.19897612	1.16391997	1.79137519	-0.9530970	0.28850080	0.467369617
Sample -19	-0.1093778	0.46736961	-0.14170875	-0.19897612	1.16391997	1.79137519	-0.9530970	0.28850080	-0.36736961
Sample -20	-0.6028251	0.50606754	-0.13774434	-0.3245009	-0.4293571	1.17228724	-0.9530970	-0.10988141	0.506067545
Sample -21	0.82976576	-2.17053913	-0.33530407	-0.53976047	-0.5742052	-0.67259483	0.28614822	-0.45378357	-0.34053913
Sample -22	0.82021515	1.24777782	-0.29698145	-0.49722726	0.29485972	-0.23923327	2.28611835	0.51650415	0.924777783
Sample -23	-0.1571302	-1.06764818	-0.34323289	-0.53094261	-0.8638872	-0.73450362	0.92417550	-0.3961670	-0.66764188
Sample -24	0.08163494	0.62861098	-0.16813814	4.18764982	-0.4293571	1.39515890	-1.2475712	0.63542688	0.328610983
Sample -25	-0.2367185	1.20907990	-0.31356589	-0.45261926	0.43970310	-0.42495965	1.77078862	0.28452974	0.609079901
Sample -26	-0.0934950	-0.28079032	1.99907226	-0.49567117	-0.1396703	-0.89546649	-0.7199717	-0.08942247	-0.28079032
Sample -27	-0.3481423	-0.47427996	-0.31211228	0.08060190	1.16391997	-0.40019613	0.17572042	-0.01635548	-0.47427961
Sample -28	0.14530565	0.36417514	-0.27980234	-0.22283621	-1.4432607	-0.02874336	-0.4254958	-0.27009421	0.223155137

This bar graph is illustrated on the basis of standard score of the water parameters which are calculated in relative conditions to their nature. Positive columns on this graph reflect the superior quality of water that means where the coastal organisms stay alive easily and get the sufficient nutrients to survive their life. On the other hand the negative columns of water signify the poor quality of water because the combination of water parameters is not suitable for the coastal habitats.

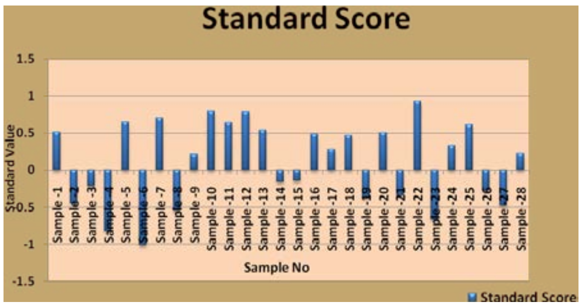

Figure 11: Standard Score Diagram

Conclusion

The study area was visited in the middle part of the month of August, before which period the low lying portion of Dakshin Purusatyampur villages was inundated by salt water encroachment during the occurrence of high spring tide phase. Both the quality of soil and water were degraded due to the temporary salt water reserve in the flooded areas of the study area. The vegetations and other organic materials were decomposed in flooded areas after a time span due to evaporation, percolation and run-off activates. However, some higher grounds were not inundated by the same event, for which number of water bodies were not affected by salt water encroachment. The relatively better quality of water represents those areas devoid of flooding activities. The qualities of coastal water bodies may restore with the occurrences of rainwater storage and washing process of the soil surface over a time span in the low lying coastal belt. Some of the plants are very sensitive to the change of water quality in the low lying coastal belt. Some areas of heath lands and grass lands were badly damaged due to prolonged inundation of salt water bodies, and vegetations were remained intact in other areas where salt water encroachment did not take place.

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