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Study on Water quality status of Vishwamitri River in Vadodara

Himani Pandey[1,3] ,Dr. G.A.Thivakaran[2]

1. Department of Earth and Environmental Sciences, K.S.K.V. Kachchh University, Bhuj-Kachchh, Gujarat-370001.
2. Gujarat Institute of Desert Ecology, Mundra road, Bhuj-Kavhchh, Gujarat-370001.
3. Institute of Technology and Management, Universe Vadodara, Gujarat.

Abstract

The river selected was studied with the regards to physical and chemical parameters and to know the pollution increase over the years by comparing it with the other data. With this intention the analysis of River Vishwamitri was carried out in the only river of Vadodara City. Four sampling stations were selected and further were analyzed for standard parameters such as pH, Conductivity, Total Dissolved Solids, Total Suspended Solids, Sodium, Potassium, Hardness, Acidity, Alkalinity, Chloride, TKN, Sulphate, Nitrite-Nitrogen, Nitrate-Nitrogen, Phosphate, Ammonical Nitrogen, COD, BOD, DO, Sulphide, and Phenolic compounds. The river water gets contaminated and the diseases occur by consuming the river water and the pollution occurs due to domestic wastes, municipal sewage, industrial discharges, hotel waste, agriculture run-off and plastics, etc. which influences the quality of river water.

Key Words:-River water quality, Fresh water ,Domestic wastes,Industrial discharge , Contamination.

Introduction:

Fresh water is a limited resource which is essential for use in agriculture, industry, propagation of wildlife and fisheries and for the human existence. India is a riverine country which has 14 major rivers, 44 medium rivers and 55 minor rivers besides numerous lakes, ponds as well as lakes which are used as primary source for drinking water without even treating.

Most of the rivers in India are being fed by monsoon rains, which are limited to only three months of the year and rest of the year the rivers runs dry often carrying the wastewater discharges from the industries or cities/towns risking the quality of our limited water resources.

Objective of the study :

The objective of the study was to check the water quality of the Vishwamitri River across the Vadodara city. Since last few years the quality of the Vishwamitri River is deteriorating. Hence, it becomes

necessary to assess the water quality of the river in the presence of contaminants to prevent its adverse effects on human health and environment.

Study Area:

Vadodara is located at 22.3072° N Latitude, 73.1812° E Longitude. Vadodara is a district in the eastern part of the state of Gujarat in western India. It covers an area of 7,794 km^2.It had a population of 36,41,802 of which 45.20 % were in urban area as of 2001 census. As of 2011 it is the third most populous district of Gujarat after Ahmadabad and Surat. The district is bounded by Panchmahal and Dahod districts to the north,Anand and Kheda districts to the west,Bharuch and Narmada districts to the south,and the state of Madhya Pradesh to the east. The tallest point in the region is Pavagadh Hill.

Pollution contribution to vishwamitri river

The Vishwamitri River passes through Vadodara City starting from Harni area to Atladra and finally joins Dhadhar River on its way it travels approximately 25 km distance within the Vadodara City.On its way the River receives pollution load from nearby societies on both the banks in the form of untreated domestic sewage waste, surface runoffs from agriculture fields and also from sewage treatment plants.

The Vadodara City is divided into three drainage zones:

Tarsali Sewage Treatment Plant (Drainage Zone I):

The sewage treated in Tarsali Sewage Treatment Plant is 52 MLD and covers all the area to the south of meter gauge railway line and east of river Vishwamitri and also includes Ward No. 4 and 12.

Gajarawadi and Kapurai Sewage Treatment Plant (Drainage Zone II):

The sewage treated in Gajarawadi and Kapurai Sewage Treatment Plant is 109 MLD and covers all the area to the north of meter gauge railway line and east of river Vishwamitri. This Sewage Treatment Plant includes Ward Nos. 1, 2, 3,5,8,9. The sewage treated from Gajarawadi and Kapurai STP is directly discharged in to the Vishwamitri River.

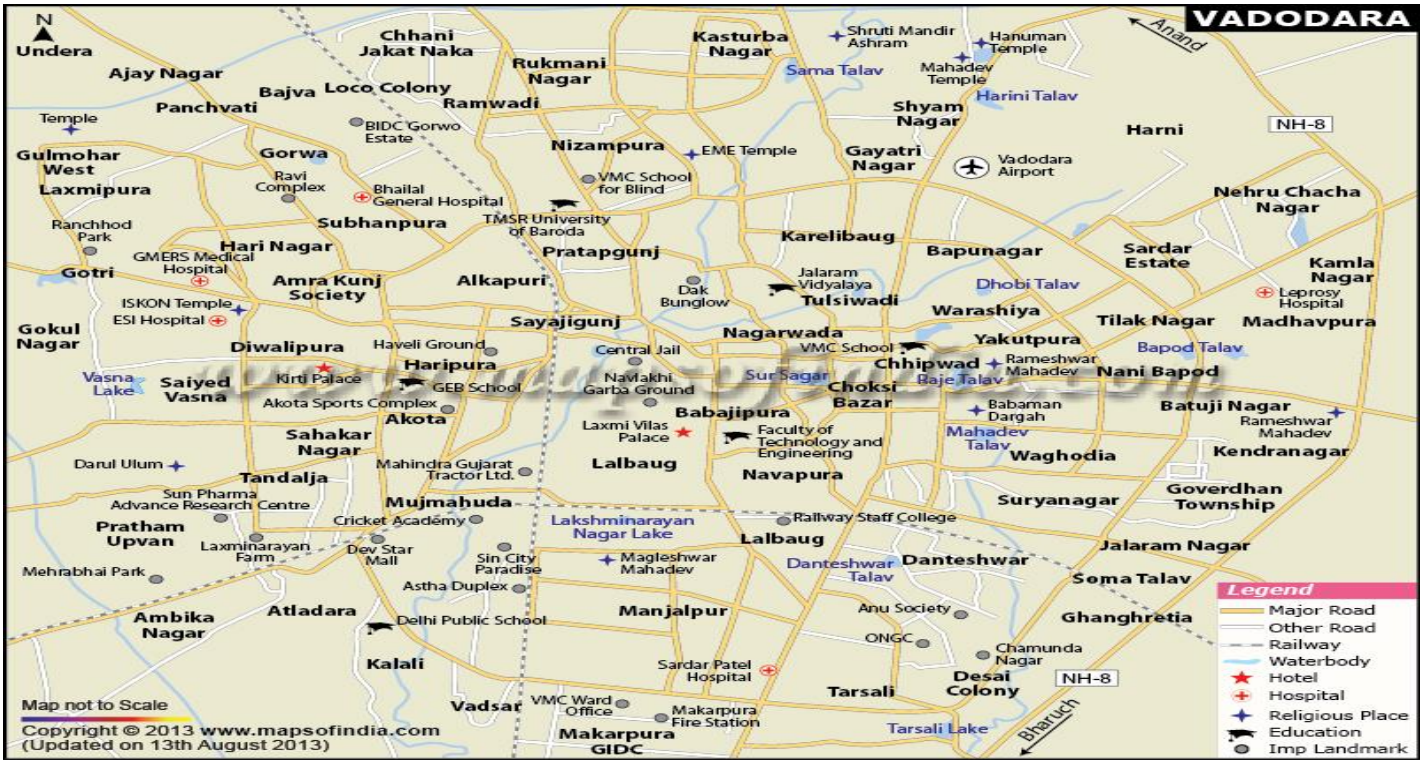
Atladra, Chhani Village and Sayaji Garden (Drainage Zone III):

The sewage treated at Atladra, Chhani Village and Sayaji Garden is 115.50 MLD. The Drainage

Zone III covers all the area to the west of river Vishwamitri and includes Ward Nos. 6, 7, 10, 11. The treated water from Atladra STP is directly discharged it into River Vishwamitri.

Table 1: Drainage Zones of Vadodara City

Drainage Zones	Collection Area	Sewage Treatment Plant	Sewage Treated in (MLD)
Zone - I Ward (4,12)	All the area to the south of meter gauge railway line and east of river Vishwamitri	Tarsali	52
Zone - II Ward (1,2,3,5,8,9)	All the area to the north of meter gauge railway line and east of river Vishwamitri	Gajarawadi & Kapurai	66 + 43 = 109
Zone - III Ward (6,7,10,11)	All the area to the west of river Vishwamitri	Atladra, Chhani Village &Sayaji Garden	43 + 43 + 21 + 8.5 = 115.50



Sampling locations

Table 2: location and sample description

SR.NO.	LOCATION	Sample code	Area	Point	GPS Location
1.	Dena Village	VS 1	Before N.H. 8 Harni	Up-stream	22°22'15"N 73°12'52"E
2.	VUDA Bridge	VS 2	Karelibaugh	Centre (about 8kms from Dena village)	22°19'37.5"N 73°11'49.6"E
3.	Bhimnath Bridge	VS 3	Sayajigunj	Centre(about 3kms from VUDA bridge)	22°18'20"N 73°11'10"E
4.	Atladra STP	VS 4	Munjmahuda	Down-stream(about 7 kms from Bhimnath bridge)	22°16'31.1"N 73°10'15.1"E

Preservation of Sample:

Table 3: Sample Preservation Methods

SR.NO.	Parameter	Preservation method	Max. Holding Period
1.	Acidity	Refrigeration at 4^oC	24 hours
2.	Alkalinity	Refrigeration at 4^oC	24 hours
3	COD	2ml/lit H_2SO_4	6 hours
4.	Fluoride	No preservation	-
5.	Ammonical nitrogen	Add 2ml 40% H_2SO_4 and make up the pH < 2, and refrigerate at 4^oC.	24 hours
6.	Nitrate	No special preservation required	-
7.	Nitrite	Add H_2SO_4 and make pH < 2, Refrigerate at 4^oC	7 days
8.	Sulphate	Refrigeration at 4^oC	7 days
9.	color	Refrigeration at 4^oC	24 hours

Table 4: Parameter Details Measured in Field

Sample Code	pH	Temperature	Time
VS1	6	25^oC	3:03 pm

VS 2	6	27°C	2:34 pm
VS 3	7	28°C	3:46 pm
VS 4	7	27°C	5:28 pm

Materials and Methods

Table 5: The below table shows the method and equipment of selected parameters.

PARAMETER	METHOD	EQUIPMENT
pH	Electrometric	pH
Conductivity	Electrometric	Conductivity meter
TDS	Filtration and evaporation at 105°C	Hot Air Oven
TSS	Filtration and evaporation at 180°C	Hot Air Oven
Sodium	Flame emission	Flame Photometer
Potassium	Flame emission	Flame Photometer
Total hardness(Ca & Mg)	Complexometric titration	-
Acidity	Acid-base titration	-
Alkalinity	Acid-base titration	-
Chloride	Argentometric titration	-
Sulphate	Turbiditimetric/$BaCl_2$ method	Spectrophotometer
Sulphide		Separating funnel
Phenol	Digestion	Spectrophotometer
Nitrate-Nitrogen	Chromotrophic acid method	Spectrophotometer
Nitrite-Nitrogen	NEDA	Spectrophotometer
Phosphate	Stannous chloride method	Spectrophotometer
Ammonical Nitrogen	Nessler's method	Spectrophotometer
TKN	Digestion followed by titration with H_2SO_4	TKN Digestor
Chemical Oxygen Demand(COD)	Digestion followed by titration with FAS	COD Digestor
Biological Oxygen Demand (BOD)	Incubation	Hot Air Oven

Compilation of results

Table 6: PHYSICO-CHEMICAL ANALYSIS REPORT (2013 – 2014)

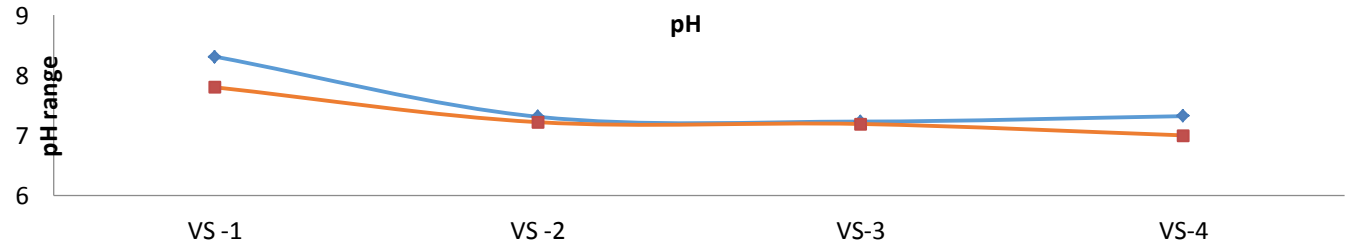
Sr. No.	Parameters	VS_1	VS_2	VS_3	VS_4
1.	pH	8.31	7.31	7.23	7.32
2.	Conductivity(µmhos/cm)	434	814	1091	1400
3.	TDS(mg/L)	250	420	570	730
4.	TSS(mg/L)	7	77	61	67
5.	Sodium(mg/L)	60	101	131	173
6.	Potassium(mg/L)	0.3	0.6	1.1	1.1
7.	Total Hardness	109.18	168.92	212.18	288.40
8.	Ca Hardness	61.80	82.40	113.30	123.60
9.	Mg Hardness	47.38	86.52	166.98	238.96
10.	Alkalinity(mg/L)	164	270	354	460
11.	Chloride(mg/L)	24.31	63.03	96.34	144.06
12.	Sulphate(mg/L)	17.76	53.64	33.29	47.41
13.	Nitrate-Nitrogen(mg/L)	0.43	0.41	0.55	0.58
14.	Nitrite-Nitrogen(mg/L)	0.00	0.01	0.01	0.01
15.	Phosphate(mg/L)	0.00	0.68	1.41	1.31
16.	Ammonical-Nitrogen (mg/L)	0.84	8.40	13.72	16.52
17.	TKN	1.4	10.64	15.12	17.36
18.	Chemical Oxygen Demand(mg/L)	48.96	147.96	189.72	178.56
19.	Biological Oxygen Demand(mg/L)	6.99	27.3	44.2	43.4
20.	Dissolve Oxygen (mg/L)	7.30	0	0	0
21.	Sulphide	BDL	0.38	1.69	1.53
22.	Phenol	0.16	0.24	0.36	0.76

Table 7: PHYSICO-CHEMICAL ANALYSIS REPORT (2016 – 2017)

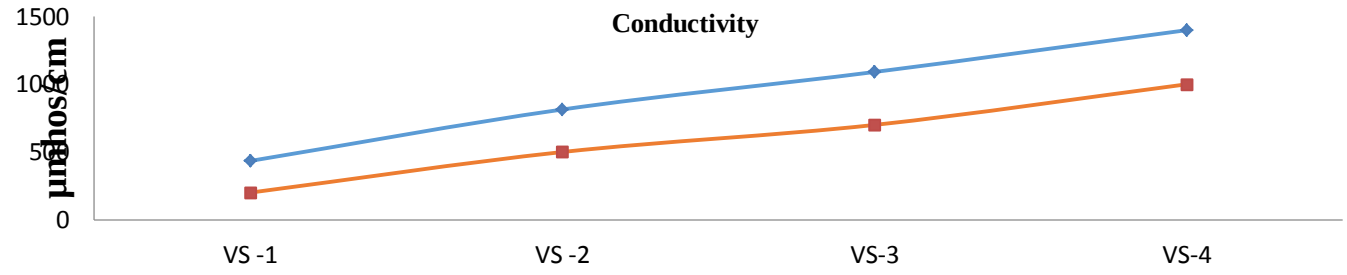
Sr. No.	Parameters	VS_1	VS_2	VS_3	VS_4
1.	pH	7.80	7.22	7.19	7.0
2.	Conductivity(µmhos/cm)	200	500	700	1000
3.	TDS(mg/L)	188.75	380	501.25	598.75

4.	TSS(mg/L)	3.63	7.5	28.75	107.5
5.	Sodium(mg/L)	25.3	76.6	113.8	141.6
6.	Potassium(mg/L)	2.7	6.6	11.1	12.5
7.	Total Hardness	248	336	392	560
8.	Ca Hardness	172	232	228	320
9.	Magnesium Hardness	76	104	164	240
10.	Acidity(mg/L)	4	12	22	30
11.	Alkalinity(mg/L)	292	228	394	397
12.	Chloride(mg/L)	12.35	66.50	90.25	116.86
13.	Sulphate(mg/L)	16.37	43.97	52.94	81.21
14.	Nitrate-Nitrogen(mg/L)	0.41	0.48	1.56	0.7
15.	Nitrite-Nitrogen(mg/L)	0.01	1.42	0.23	0.01
16.	Phosphate(mg/L)	0.005	0.45	0.73	1.22
17.	Ammonical-Nitrogen (mg/L)	0.55	9.68	17.11	18.29
18.	TKN (mg/L)	5.66	13.8	20.21	21.54
19.	Chemical Oxygen Demand(mg/L)	8.5	28.3	93.85	129.69
20.	Biological Oxygen Demand(mg/L)	2.15	4.10	32.46	50.64
21.	Dissolved Oxygen (mg/L)	8.54	2.83	0	0
22.	Sulphide	BDL	0.12	0.46	1.25
23.	Phenolic Coumpounds	0.06	0.34	0.11	0.32

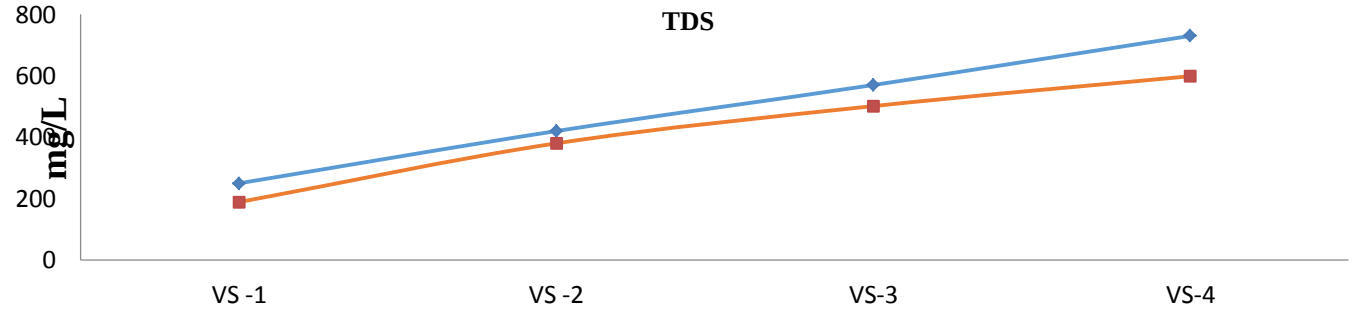
Results and Discussion



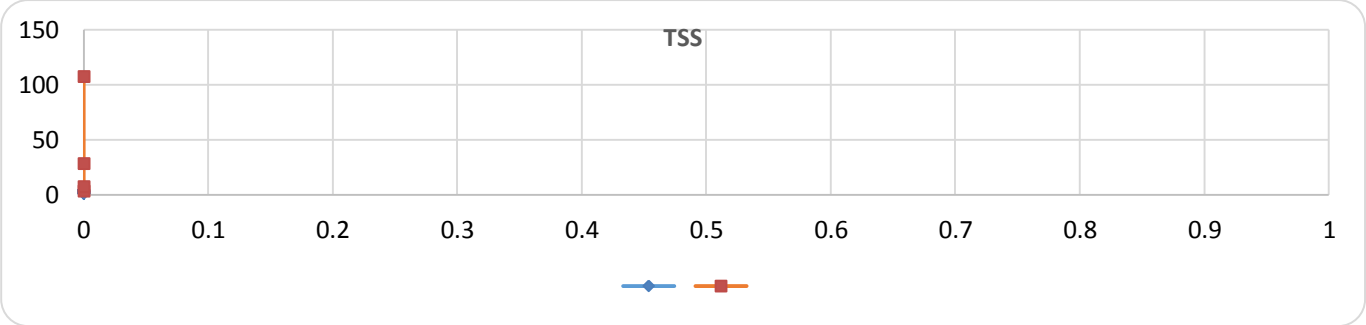
The above graph shows the comparative data of the pH of the sampling locations. The highest variation was seen in Dena Village (VS-1) and the less variation was seen in Bhimnath Bridge (VS-3) as compared to the above data.



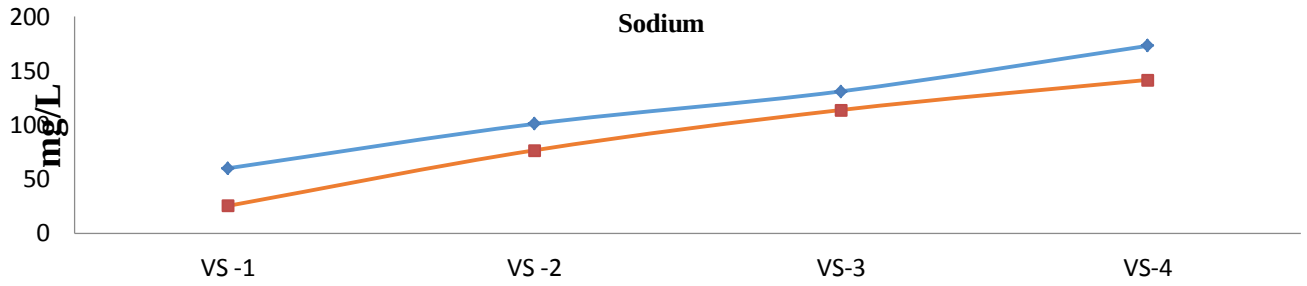
The above graph shows the conductivity change over the years on the sampling locations. The highest variation was seen in Atladra(VS-4) and the less variation was seen in Dena Village (VS-1). The temperature increases the conductivity of water increases as in evaporation process the water is taken up but the salts will remain in the water only so enough of rain is necessary. The data shows the quality of river is improving due to proper STP functioning



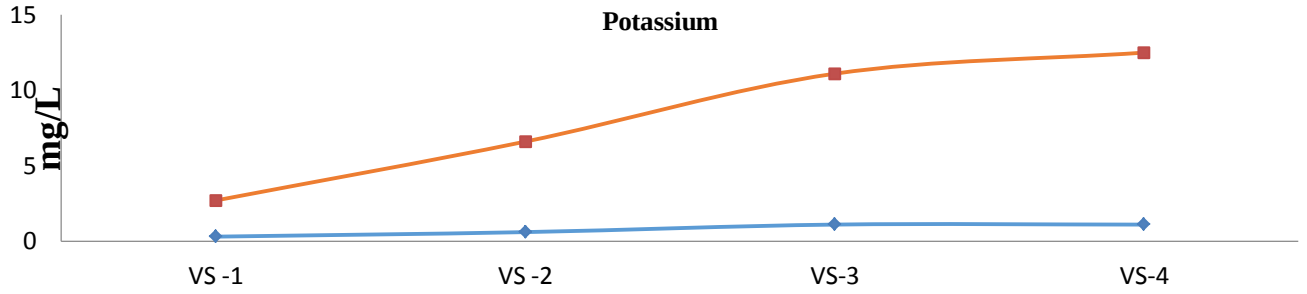
The above graph shows the comparative data of TDS of the sampling locations. The highest variation was seen in VS-4 (Atladra) and the less variation was seen in VUDA Bridge (VS-1) and the TDS is in the prescribed range of 2000 but the desirable limit is 500 and that limit was crossed by Bhimnath Bridge (VS-3) and Atladra (VS-4). The high TDS affects the taste and odour of the water and above 300 mg/L level the water becomes highly unacceptable. The TDS level is going down due to diversion of drains into STP sand reduction of direct discharges into the river.



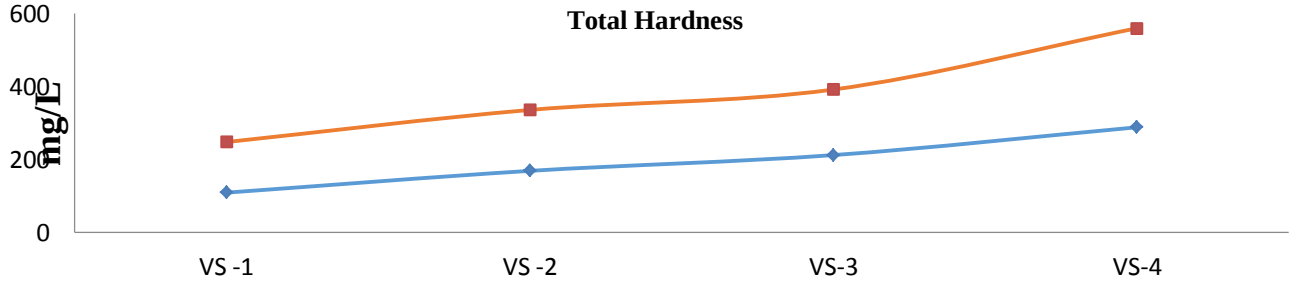
The above graph shows the comparative data of the TSS of the same sampling locations. The highest variation was seen in VUDA Bridge (VS-2) and the less variation was seen in Dena Village (VS-1) because at VUDA Bridge the water flowing was used for washing clothes and cattle's used to take bath over there so the TSS was found to be more than VUDA Bridge (VS-2) where the Vishwamitri River will enter the Vadodara City. The high TSS in surface water leads to death of many aquatic organisms. The TSS was highly fluctuating throughout the Vishwamitri River as seen in the above graph-4. The TSS value is exceeding from the earlier result in the location VS-4 due to mixing of STPs and drains located nearby this sampling point.



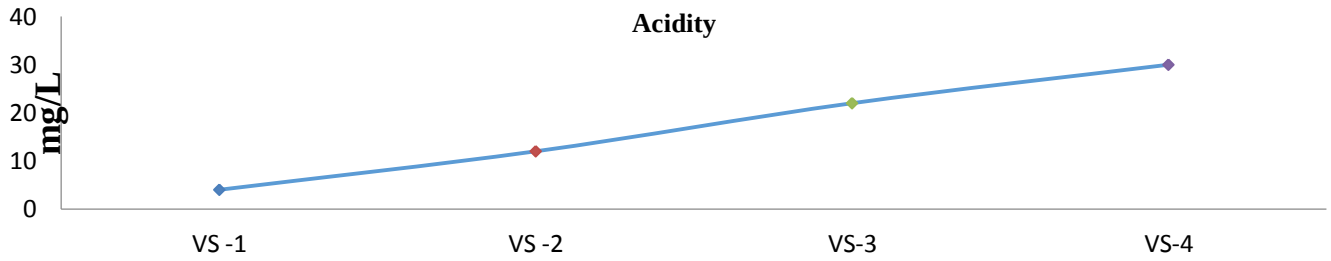
The above graph shows the change of sodium in the water. The higher amount of suspended solids was seen in Dena Village (VS-1) and less was seen at VS-3 (Bhimnath Bridge). The Sodium gradually increases from Dena village (VS-1) to Atladra (VS-4). The high amount of sodium content in water leads to damage in heart, kidney, etc. The Sodium level is going down due to diversion of drains into STP sand reduction of direct discharges into the river.



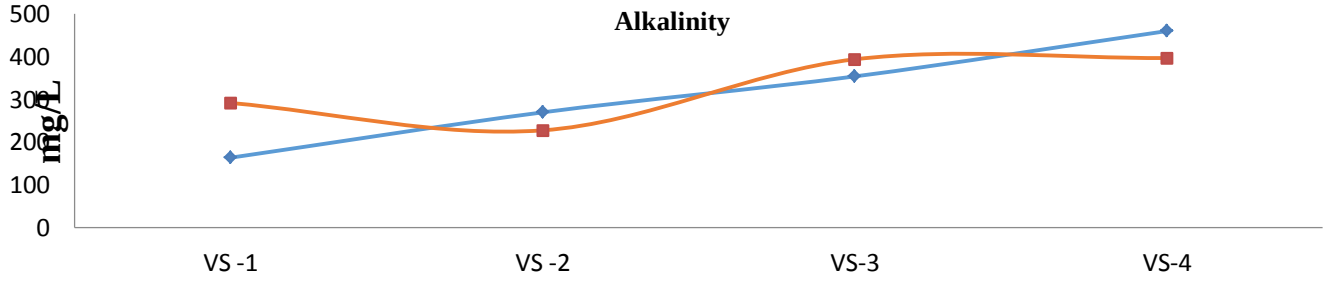
The above graph shows the change in potassium over the years. The amount of potassium is gradually increased as compared to the older data. Steady increase of potassium content is seen from Dena village (VS-1) to Atladra (VS-4). The Potassium level is exceeding from the earlier result due to agricultural run-off, cattle bathing and washing activities.



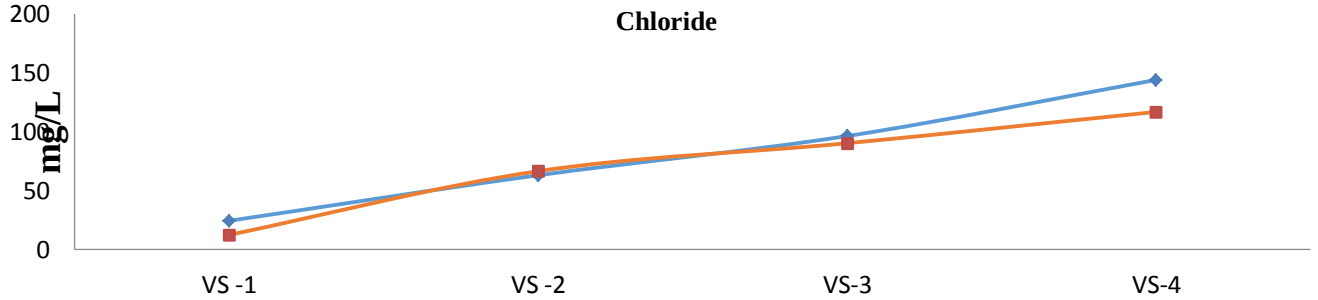
The above graph shows the change in Total Hardness of the river. The Total Hardness depends on the Ca and Mg ions in the water. Here, there is continuous increase in total hardness from Dena village (VS-1) to Atladra (VS-4). This may be due to the disposal of sewage into the river which decreases the water quality. The hardness exceeds the desirable limit of 300 mg/L in four locations i.e. Dena Village (VA-1), VUDA Bridge (VS-2), Bhimnath Bridge (VS-3) and Atladra (VS-4). The Total Hardness level is exceeding from the earlier result due to Household uses RO rejects, cattle bathing and washing activities.



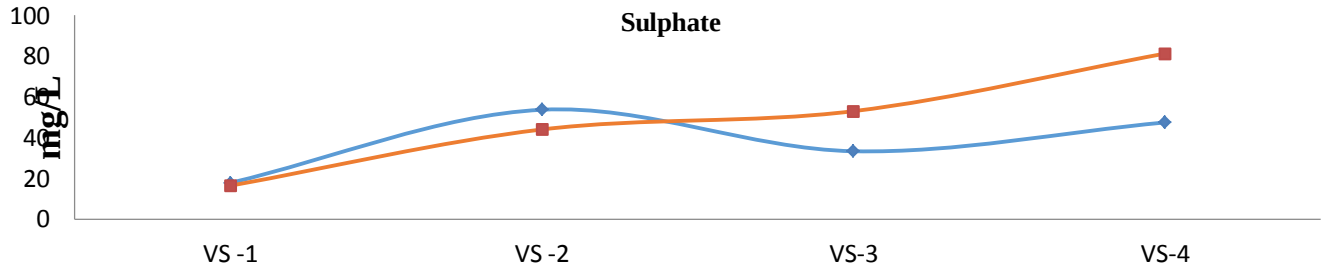
The above graph shows the gradual increase in the acidity of the river Vishwamitri as the river flows from Dena village (VS-1) to Atladra (VS-4). This might because the increase in the domestic waste, sewage disposal into the river.



The higher alkalinity presence was seen in Downstream Area (Bhimanth Bridge (VS-3) and Atladra (VS-4)) because of the presence of Carbonates, Bicarbonates and Hydroxide content. The highest alkalinity was seen at Atladra (VS-4). The Alkalinity in all the locations exceeds the desirable limit of 200 mg/L. The alkalinity level exceeded in VS-1 and VS-3 and decreases in VS-2 and VS-4. The changes may observed due to variation in pH and other activities on the river bank.

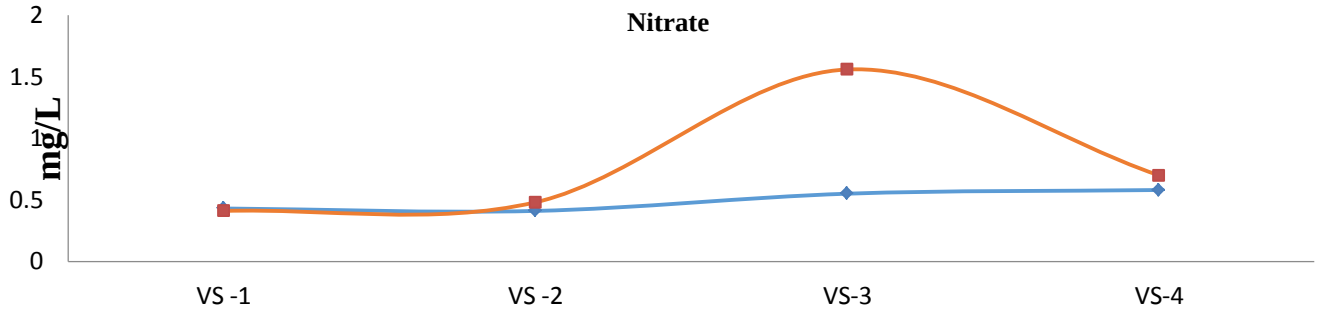


The above graph shows the chloride change over the years in the water body. The gradual increase of chloride content is seen from Dena village (VS-1) to Atladra (VS-4). The chloride level reduced in sampling location VS-1 due to none activity found at the time of sampling.

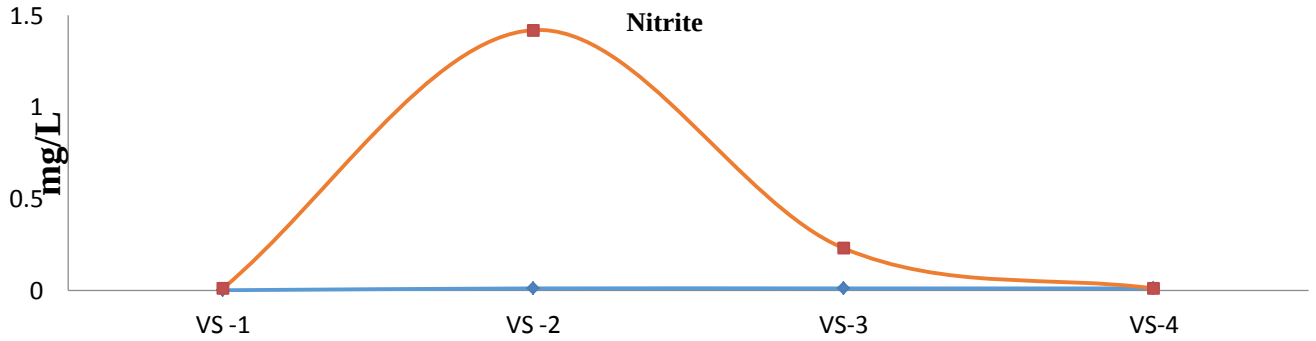


The above graph shows the sulphate concentration change in River Vishwamitri over the years. Steady growth is seen as the River Vishwamitri flows through the Vadodara City. Highest Sulphate was observed at Atladra (VS-4) after the STP and slightly low Sulphate than Atladra (VS-4) STP was observed near Bhimnath Bridge (VS-3) as the waste is thrown directly into the river which pollutes the

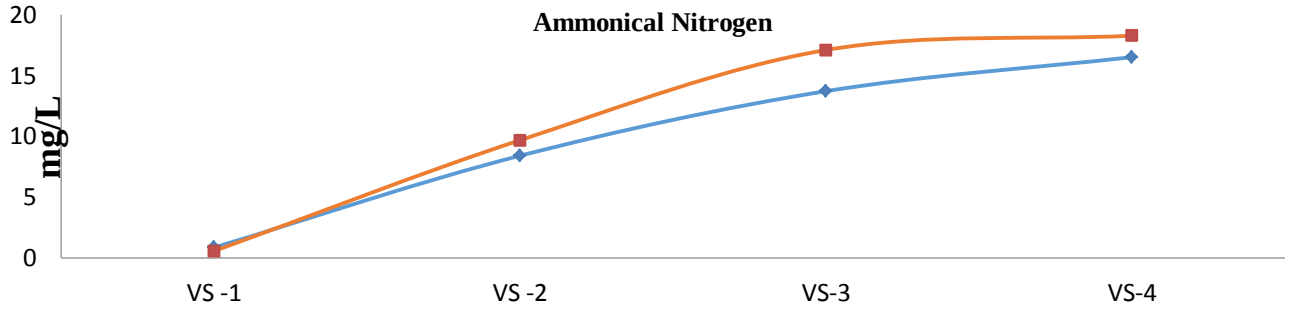
river and slows the flow of the river. The desirable limit is 200mg/L and all the readings were below the desirable limit. The Sulphate level exceeded in VS-3 and VS-4 and decreases in VS-1 and VS-2. This may be due to variation in flow in sampling locations.



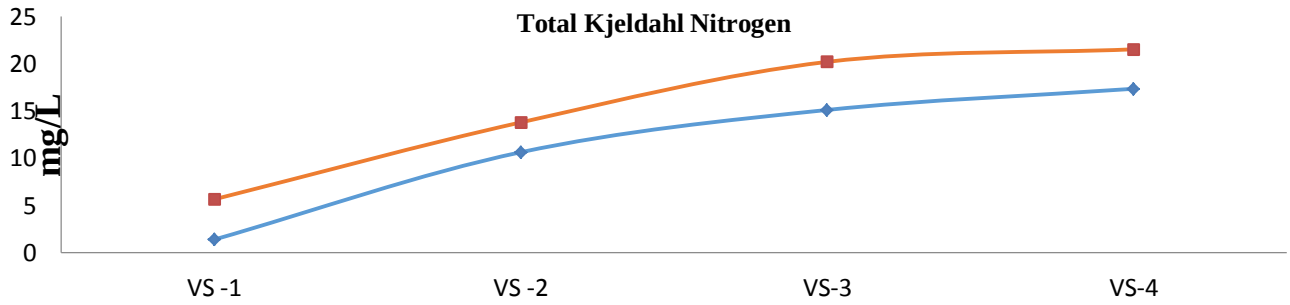
The above graph shows the nitrate concentration change over the years in River Vishwamitri. The highest nitrate concentration was observed near Bhimnath Bridge because at few meters away the waste dumping is been carried out which pollutes the river. The Nitrate level exceeds in VS-2, VS-3 and VS-4 and decreases inVS-1. This may be due to more population of crocodile at sampling location VS-3.



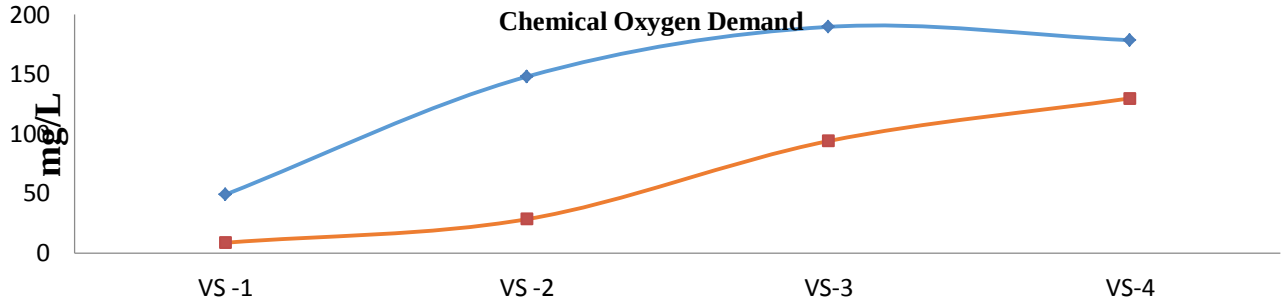
The above graph shows the nitrite concentration in river vishwamitri. Nitrite was present in trace amounts at Dena Village and Atladra. Little bit of nitrite concentration was observed near Bhimnath Bridge and the highest concentration of nitrite was observed near VUDA Bridge (VS-2) as the people used to wash their clothes and used to send their cattle for bathing and near to it the owners of the shop at Ratri Bajar used to dump the waste water into the river water.



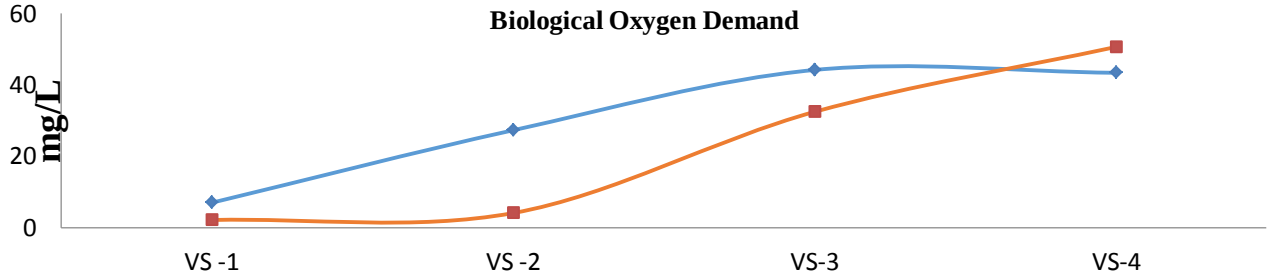
In above graph the concentration of ammonical nitrogen at Dena Village (VS-1) is very less as compared to other locations. It gradually increases as the river passes through the city and gets polluted by various ways such as sewage disposal, dumping of domestic waste, etc. Highest concentration was observed at Atladra. This may be due to increase in flow in the river was observed high as compared to the earlier data.



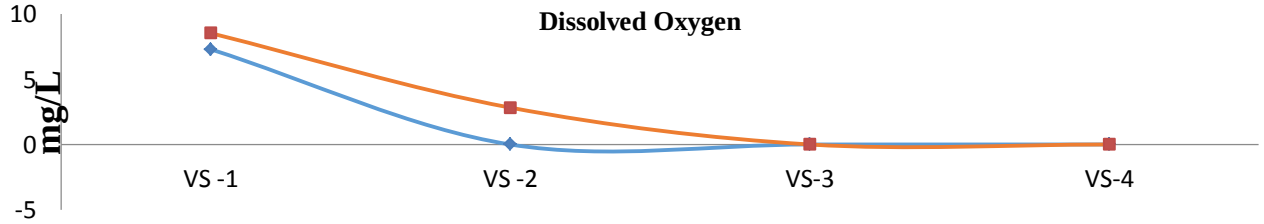
The above graph states the change in TKN of the river over the years. The highest TKN concentration was observed at VUDA Bridge (VS-2), Bhimnath Bridge (VS-3) and Atladra (VS-4). This may be due to increase in flow in the river was observed high as compared to the earlier data in the River Vishwamitri that leads to the pollution in the river water.



The above graph shows COD in the river water sample change over the years. The COD test has a higher accuracy in the results than BOD. The higher COD was observed in Bhimnath Bridge (VS-3) and Atladra (VS-4). The COD values are decreasing due to better treatment in STPs and diversion of drains into the STPs.

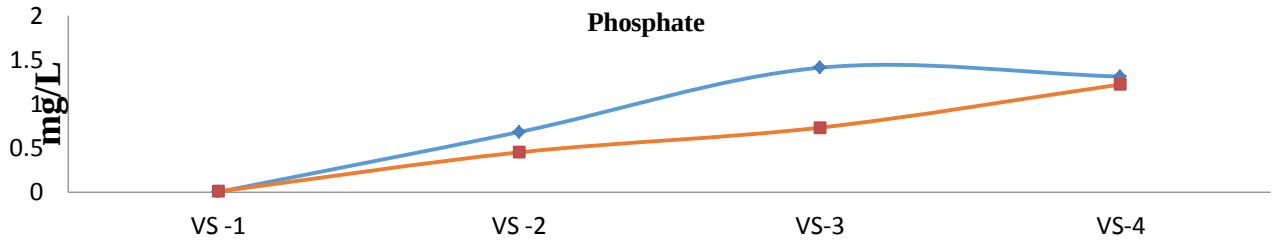


The above graph shows the BOD concentration change over the years in the river water. The BOD values are decreasing in sampling locations VS-1, VS-2, VS-3 and increasing in sampling location of VS-4. The BOD value is increasing in sample location VS-4 due to open dumping of municipal solid waste and discharges from nearby STPs.

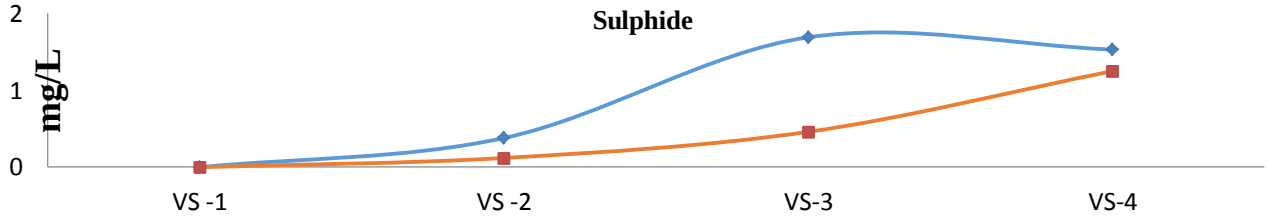


The DO graph above stats the change in the concentration in the river water over the years. The DO values is increasing in sample location VS-1, VS-2 and no change is observed in sample location VS-3, VS-4. The DO level increasing due to fresh water in sampling location VS-1 and diversion of sewage

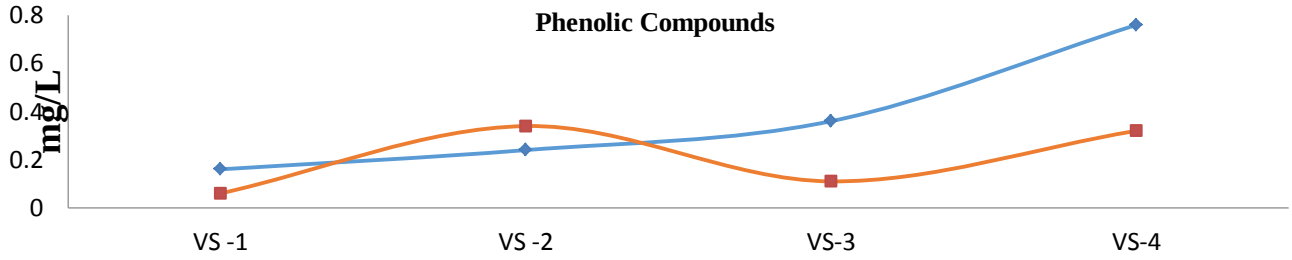
drains into STP Sayajigunj from sampling location VS-2.



The above graph shows the amount of change in phosphate concentration in the river water over the years. The Phosphate level was observed low in all location due to diversion of sewage drains and better performance of STPs.



The above graph shows the variation of Sulphide concentration in the river water over the years. The Sulphide level was observed low in all location due to diversion of sewage drains and better performance of STPs.



The above graph shows the little variation in the phenol concentration in the river water over the years. The source of phenolic compounds is industrial as compared to the domestic waste water. The values exceeds at sampling location VS-2 is due to commuter activities in Ratri Bajar.

Conclusion

- The water quality of Vishwamitri River is been improving as compared to earlier data. This may be due to diversion of all sewage drains into STPs, better sewage system and proper functioning of sewage treatment plant.
- Need of the hour is to stop the illegal discharge of domestic sewage and industrial discharge to rejuvenate the life in the river can be done by interlinking with other river.
- The river water quality should much improved for the protection of crocodile population and wildlife.
- Local authorities must ensure the quality of the river by way not allowing any discharge and any waste disposal into the river.

- The VMC must be accountable for improving sewage system of the city and proper functioning of sewage treatment plant.

Suggestions

- The water coming from sewage treatment plants (STPs) should be properly treated and then discarded into the river.
- The new STP if made must be designed considering future aspects.
- The VMC should have an Environment Department and should lead by a qualify personal.
- Dumping of construction debris and other solid waste into the river should be banned and if done by any person should be penalized heavily.
- As the government is planning a river front project on the banks of River Vishwamitri is very nice idea to protect the River.
- Till then fencing on the banks of River Vishwamitri should be done in order to stop the localities from directly throwing the garbage from the bridge.
- Awareness among the residents should be created to stop the decreasing of water quality in river.

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