Study of Change in Water Quality at Different Distances form Sea in Mahi Estuarian Area

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Abstract. Main perennial rivers of Gujarat, Tapi, Narmada, Mahi and Sabarmati are meeting Arabian Sea in Gulf of Khambhat. The out flow of Mahi River into the sea is decreased due to construction of dams like Bajaj Sagar, Kadana, Panam and Wanakbori weir. So, Tidal effect of sea and sea water intrusion is being increased on landward side. Moreover, due to erratic nature of rainfall and improper management of the existing water resources in the region, the ground water withdrawal rate has increased. Since the existing ground water resources have not been replenished as per demand, Mahi estuarian area is facing a problem of sea water intrusion. Day by day quality of ground water and soil going on deteriorating. An attempt is made to study the pre and post-monsoon ground water quality by collecting and analyzing the water samples of open well, bore well etc. Considering radial distances from Kavi Town (sea) i.e. to study the effect of salinity ingress. It is observed that as the distance from Kavi village increases, the T.D.S, Cl and, TH, values decreases. The high pre-monsoon values get normalized after the post monsoon because of rain water recharge and dilution, except some locations due to many reasons.

Keywords: Sea water intrusion, Salinity, Ground water, Ground water quality, Estuary.

Introduction

The Mahi River is one of the major west's flowing perennial rivers and flowing through Central Gujarat into the Gulf of Cambay near Kavi village. The Mahi river originates from Mahud Tank on the northern slopes of the western flank of Vindhyas mountain range at about 22° 35´ N and 74° 15´E near the village Sardarpur in district Dadarpur of Madhyapradesh. First it flows in Jhabua Dhar districts and Ratlam district before entering Rajasthan and then Gujarat. Total length of the Mahi River is 583 Km. Out of which 167 km in Madhya Pradesh, 174 km in Rajasthan and 242 km in Gujarat. In Gujarat it passes through Panchmahal, Anand andVadodara District.

This estuarian area is lying under three district viz. Vadodara district (Vadodara, Padra and Savli Talukas) on left bank, some portion of Bharuch district (Jambusar Taluka) on left bank at meeting point of river and sea and Anand district (Ananad, Anklav, Borsad, Petlad and Khambhat or Cambay Talukas) on right bank of Mahi river.

The study was conducted to study the pre and post monsoon effects on the ground water quality by collecting the water samples of open well, borewel, etc. considering radial distances from Kavi Town (the meeting point of the Mahi river and Sea) i.e., to study the effect of salinity ingress.

Details of Study Area

Mahi River meets gulf of Khambhat near Kavi Town. This estuarian area lies between 22º 05´ 06" to 22° 33´ 36" North Latitude and 72º 27´ 18" to 73° 13´ 57" East longitude. The total approximate area by planimeter is about 2298.23 sq. km. (Fig.1) the area between Wanakbori to Gulf of Cambay is gently sloping to almost flat near the Gulf and is a fully developed and fertile alluvial tract. The type of soil is deep black coastal alluvium in Bharuch district and medium black in Vadodara and Anand districts. The geology is recent to sub-recent alluvium. The climate is semi-arid (moist) to dry, sub-humid. Average temperature during winter and monsoon is 30°C and during summer is 43°C. Rainfall range of annual rainfall is 750-1100 mm for Anand, Vadodara and Bharuch districts.

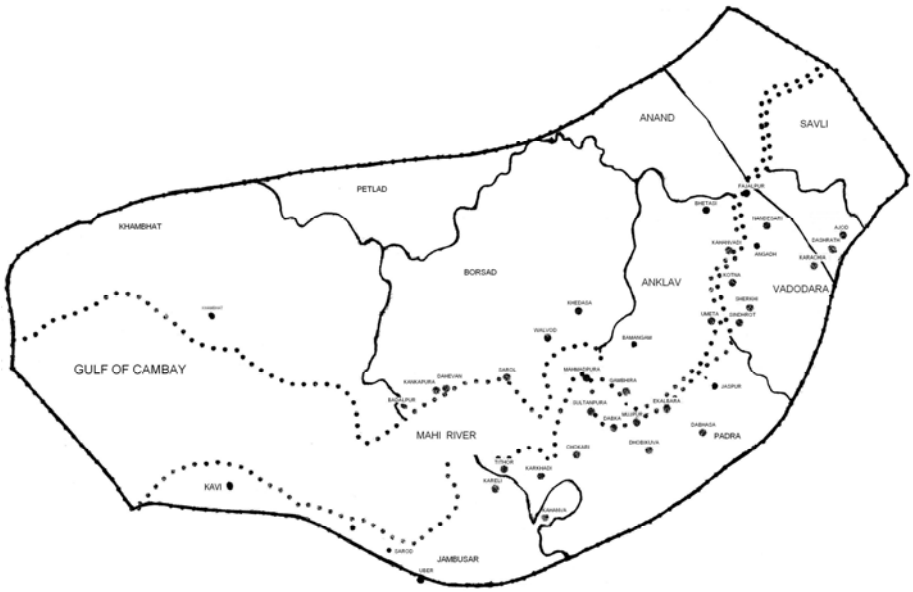


Fig. 1. Map Showing Mahi Estuarian Area

Methodology

To get the comprehensive picture of change of water quality in Mahi estuarian area in pre and post-monsoon season. The representative water samples were collected from surrounding bore well / open well and tube wells parallel to the Mahi River on both sides within 10 km distance from river in one lit. Plastic container in May-June for the pre-monsoon and in November for post-monsoon period of year 2003. We collected about 36 samples. The water samples then were analyzed for different important chemical parameters like PH, EC, T.D.S., Cl, CO3, HCO3, TH, Na, Ca, Mg, K, So4 to evaluate water quality in Environmental Engineering Laboratory, Civil Engg. Department, Faculty of Technology and Engineering, the M S University of Baroda, Vadodara.

Analysis and Results

Results obtained in the laboratory are recorded as statement of different chemical analysis of Mahi estuarian area (distance from Kavi) (Table1) These laboratory results are also represented graphically to see at a glance the change of ground water quality inMahi estuaurian area in pre-monsoon and post- monsoon season.

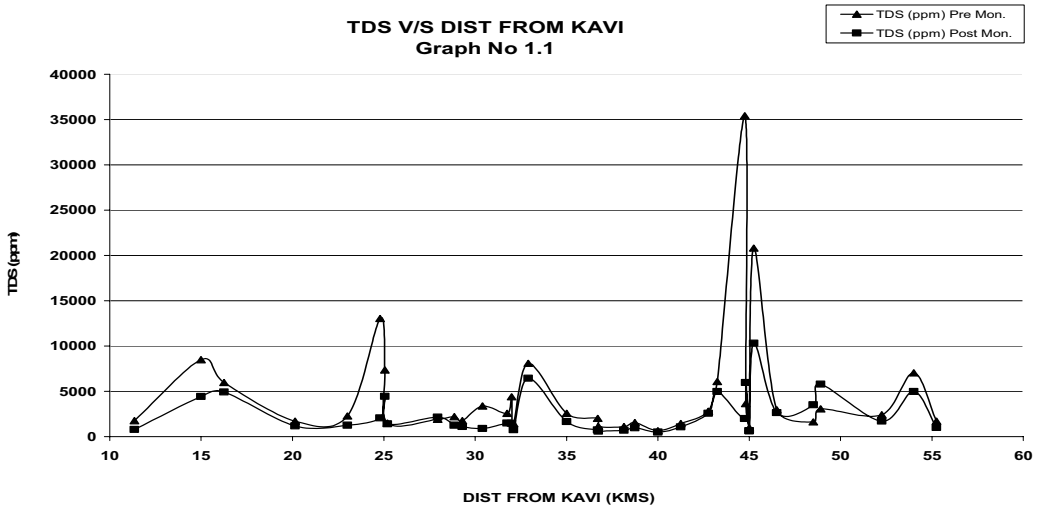
T.D.S. (Total dissolved solids) v/s distance from Kavi. (graphs 1.1,1.2,1.3)

Cl (Chlorides)v/s distance from Kavi (graphs 1.4,1.5,1.6)

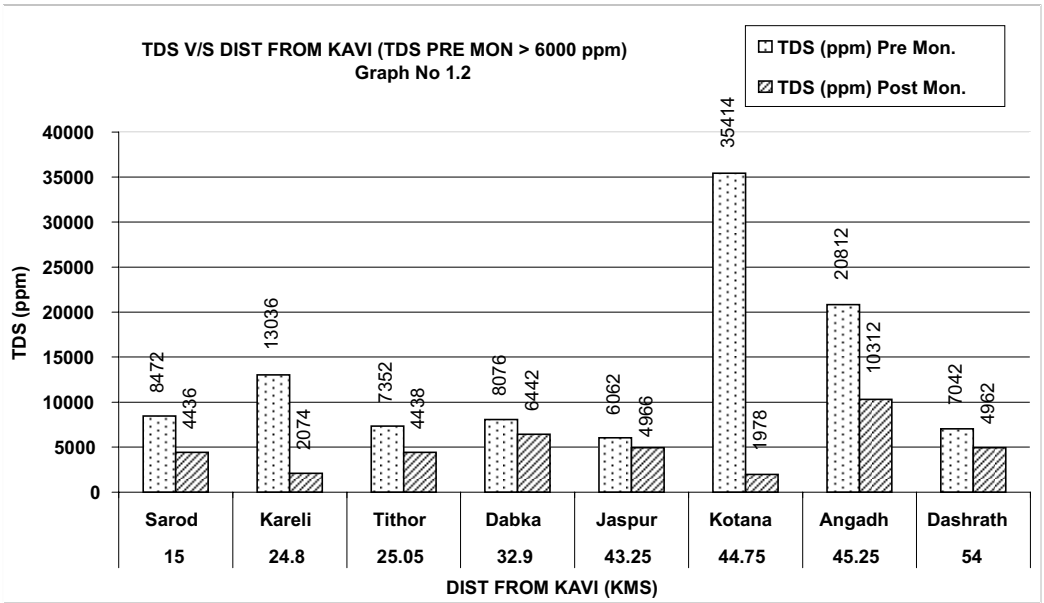
TH (Total hardness)v/s distance from Kavi (1.7,1.8,1.9)

Table 1. Statement OF Different Chemical Analysis of Mahi Estuarian Area (DIST. form KAVI)

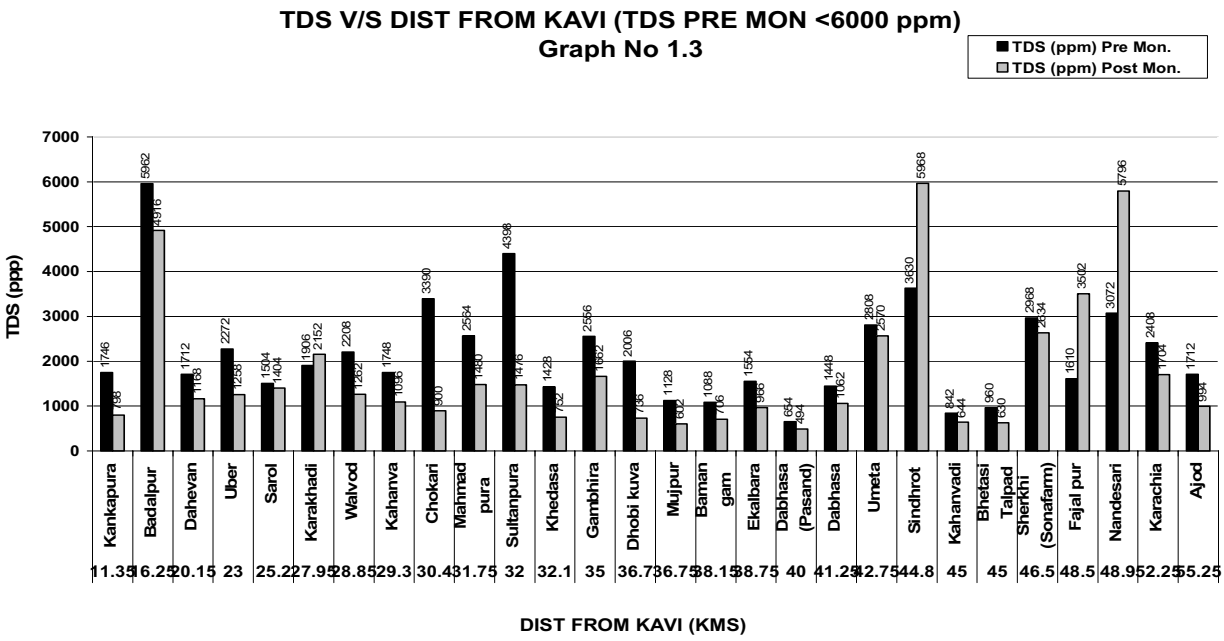
Sample No.	dist.from kavi km	Village	EC (mmhos/cm)		pH		TDS (ppm)		Ca++ (ppm)		Mg++ (ppm)		Na+ (ppm)		Co3 (ppm)		HCO3 (ppm)		Cl- (ppm)		SO4 (ppm)		K (ppm)		T.H (ppm)	
			Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.	Pre Mon.	Post Mon.
18	11.35	Kankapura	502	1041	7.9	8.93	1746	798	33.65	56	33.02	14.33	--	--	Nil	Nil	707.6	420	999.69	259.92	--	--	--	--	169.62636	115
21	15	Sarod	3250	5950	7.6	8.27	8472	4436	180.27	356	177.27	81.11	--	--	Nil	Nil	793	280	5248.37	2199.3	--	--	--	--	910.26786	690
23	16.25	Badalpur	2560	5390	7.6	8.22	5962	4916	220.33	184	179.69	183.6	1723	671.6	Nil	Nil	536.8	130	4398.63	2149.3	8.8	381.4	13.68	4.7	960.29342	940
13	20.15	Dahevan	681	1440	8.6	8.78	1712	1168	28.04	32	33.99	15.3	--	--	18	Nil	1024.8	690	299.9	319.9	--	--	--	--	168.01082	95
28	23	Uber	1358	1385	7.7	8.47	2272	1258	92.14	120	63.13	20.64	--	--	Nil	Nil	671	280	1449.53	449.86	--	--	--	--	352.10934	205
15	24.8	Kareli	4050	3410	7.5	8.26	13036	2074	248.37	228	206.41	66.05	--	--	Nil	Nil	732	380	5498.29	1099.7	--	--	--	--	1098.3664	500
19	25.05	Tithor	3400	5780	6.9	8.2	7352	4438	192.28	92	211.22	161	--	--	Nil	Nil	707.6	260	7747.59	2374.3	--	--	--	--	1062.084	755
32	25.2	Sarol	872	1690	8.4	8.58	1504	1404	36.85	144	52.65	13.6	--	--	Nil	Nil	817.4	480	999.69	459.86	--	--	--	--	253.6627	200
29	27.95	Karakhadi	1090	2980	8	8.55	1906	2152	43.26	96	56.34	30.11	--	--	Nil	Nil	915	600	1399.56	974.7	--	--	--	--	275.26812	220
31	28.85	Walvod	1290	1447	8.5	8.53	2208	1262	40.06	72	212.41	73.58	--	--	Nil	Nil	793	470	1199.62	309.9	--	--	--	--	914.76438	375
4	29.3	Kahanva	874	1513	7.6	8.45	1748	1096	60.09	182.5	58.28	47.97	--	--	Nil	Nil	805.2	300	659.8	579.82	--	--	--	--	300.08704	380
6	30.4	Chokari	2840	1235	7.5	8.45	3390	900	220.03	52	218.55	43.22	1774	237	Nil	Nil	585.6	420	3099.03	349.89	82.3	12.34	17.25	6.65	1120.0189	230
20	31.75	Mahmad pura	1300	1836	7.8	8.44	2564	1480	35.25	44	39.34	16.03	--	--	Nil	Nil	896.6	540	1799.44	439.86	--	--	--	--	197.25212	110
26	32	Sultanpura	1990	1651	7.6	8.69	4398	1476	120.18	68	145.7	22.34	--	--	Nil	Nil	695.4	490	2199.31	459.86	--	--	--	--	720.1726	160
12	32.1	Khedasa	473	998	8.3	8.6	1428	752	32.04	64	58.28	34.24	--	--	Nil	Nil	902.8	510	399.87	299.91	--	--	--	--	272.03704	205
35	32.9	Dabka	4190	6900	7.4	8.32	8076	6442	204.3	410	271.98	245.3	3878	311.3	Nil	Nil	610	210	7197.76	2924.1	318	268.38	7.36	4.66	1324.3136	1420
16	35	Gambhira	1250	2860	7.9	8.45	2556	1662	56.08	52	21.85	33.5			Nil	Nil	878.4	510	1999.38	519.84	--	--	--	--	146.0583	190
11	36.7	Dhobi kuva	632	993	7.8	8.97	2006	736	36.05	44	46.14	12.38	1787	244.5	Nil	Nil	805.2	510	549.82	179.94	257	23.4	4.709	1.52	226.05452	95
17	36.75	Mujpur	400	911	7.9	8.38	1128	602	60.09	128	48.56	19.91	--	--	Nil	Nil	805.2	330	1199.62	219.93					260.06008	210
5	38.15	Baman gam	456	947	8.4	8.4	1088	706	26.03	59.65	57.06	42.58	--	--	Nil	Nil	780.2	350	280	269.92	--	--	--	--	261.00308	235
3	38.75	Ekalbara	443	1113	7.8	8.29	1554	966	80.12	214	97.13	56.09	--	--	Nil	Nil	549	170	359.88	419.87	--	--	--	--	480.10134	445
7	40	Dabhasa (Pasand)	333	709	7.8	8.5	654	494	24.03	60	21.85	13.36	--	--	Nil	Nil	585.6	300	199.9	269.92	--	--	--	--	114.0083	115
1	41.25	Dabhasa	833	1444	8	8.62	1448	1062	86.53	56.14	42.25	47.08	--	--	Nil	Nil	488	340	434.86	419.87	--	--	--	--	260.5155	250
34	42.75	Umeta	1270	2950	7.8	8.11	2808	2570	132.19	256	106.85	90.82	--	--	Nil	Nil	646.6	150	1499.53	824.74	--	--	--	--	572.1983	630
8	43.25	Jaspur	2410	6120	7.3	7.76	6062	4966	212.3	480	182.12	201.6	--	--	Nil	Nil	549	110	1999.4	2649.2	--	--	--	--	962.27016	1310
14	44.75	Kotana	16400	3220	7.6	8.44	35414	1978	681.02	72	655.5	83.29	--	--	Nil	Nil	488	230	15995.07	909.72	--	--	--	--	3380.369	415
30	44.8	Sindhrot	1976	6030	7.8	8.15	3630	5968	156.23	400	123.85	170	--	--	Nil	Nil	549	130	3398.94	2499.2	--	--	--	--	666.2443	1100
9	45	Bhetasi Talpad	430	912	7.4	8.63	960	630	52.07	68	48.56	49.05	--	--	Nil	Nil	658.8	380	474.85	249.92	--	--	--	--	252.04008	270
22	45	Kahanvadi	328	797	8	8.38	842	644	76.11	48	43.71	38.13	--	--	Nil	Nil	695.4	330	599.81	199.94	--	--	--	--	256.10778	205
36	45.25	Angadh	12100	10630	7.2	7.85	20812	10312	1301.95	1120	1104.9	480.8	--	--	Nil	Nil	451.4	100	14995.3	6697.9	--	--	--	--	5851.9282	3100
33	46.5	Sherkhi (Sonafarm)	1420	2820	7.9	8.37	2968	2634	196.29	424	220.98	137.5	--	--	Nil	Nil	707.6	170	1199.62	824.74	--	--	--	--	1106.2856	990
2	48.5	Fajal pur	1210	4970	7.6	8.51	1610	3502	240.36	266.7	194.2	27.52	--	--	Nil	Nil	524.6	170	2199.3	2024.4	--	--	--	--	1040.0756	380
27	48.9	Nandesari	1260	6790	7.6	8.19	3072	5796	216.3	408	109.27	124.3	--	--	Nil	Nil	622.2	140	1249.61	2924.1	--	--	--	--	666.27386	920
10	52.25	Karachia	955	2910	7.5	8.21	2408	1704	152.2	128	104.4	87.9	--	--	Nil	Nil	793	340	799.75	669.79	--	--	--	--	582.1192	490
25	54	Dashrath	2200	5120	6.6	8.2	7042	4962	640.96	980	330.25	408	--	--	Nil	Nil	475.8	180	499.84	399.88	--	--	--	--	2000.9295	2660
24	55.25	Ajod	578	1153	7.8	8.39	1712	994	64.09	44	46.13	40.3	--	--	Nil	Nil	732	280	999.69	369.89	--	--	--	--	254.05334	210



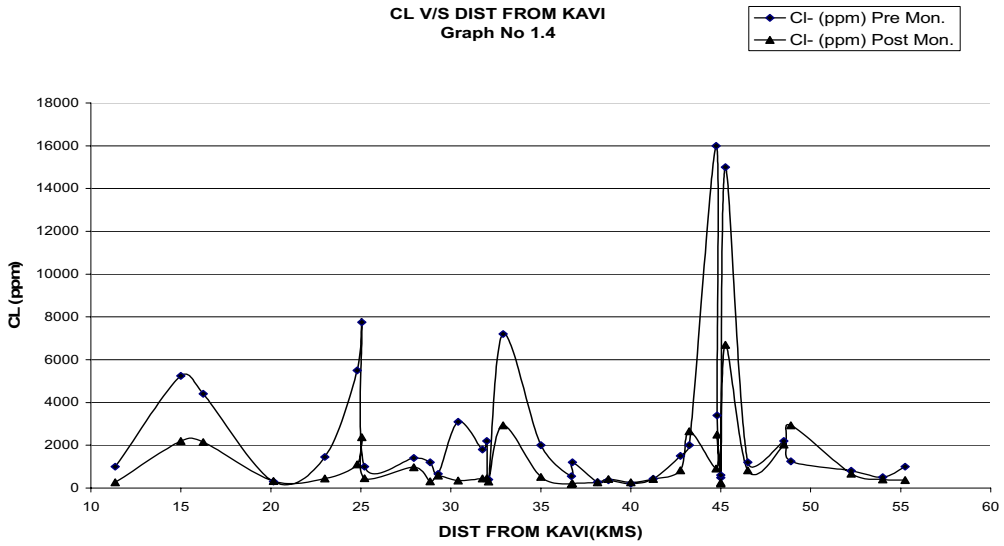
Graph 1.1. Total Dissolved Solids v/s Distance from Kavi



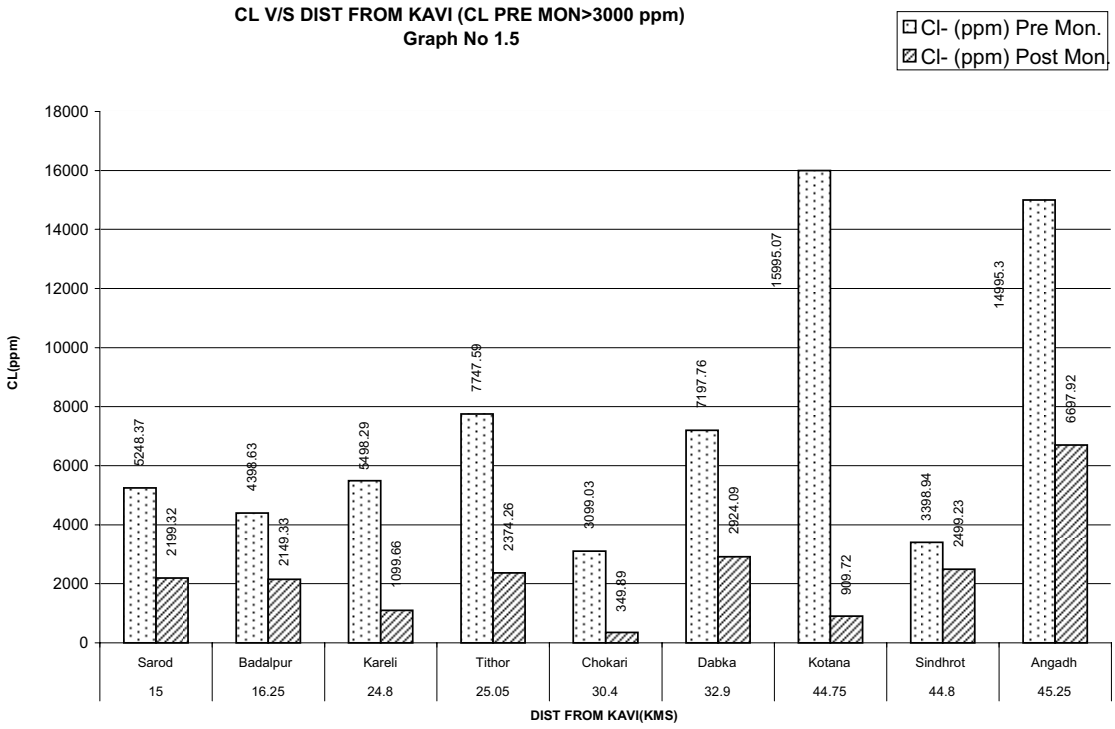
Graph 1.2. Total Dissolved Solids v/s Distance from Kavi (Pre-Monsoon TDS>6000ppm)



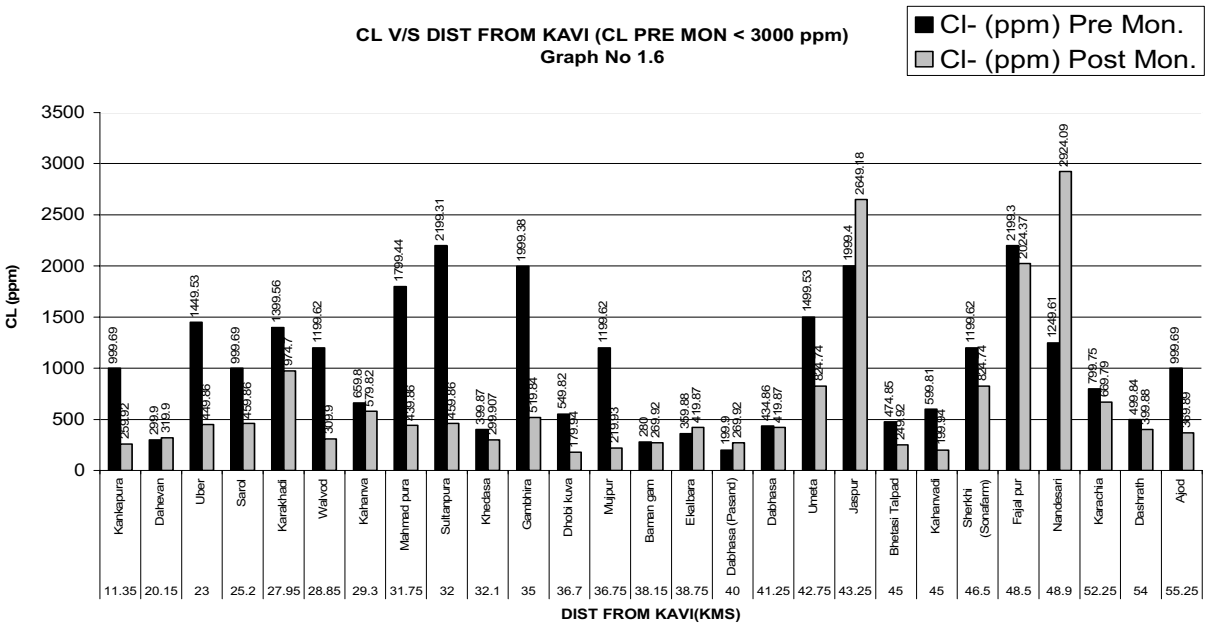
Graph 1.3. Total Dissolved Solids v/s Distance from Kavi (Pre-Monsoon TDS<6000ppm)



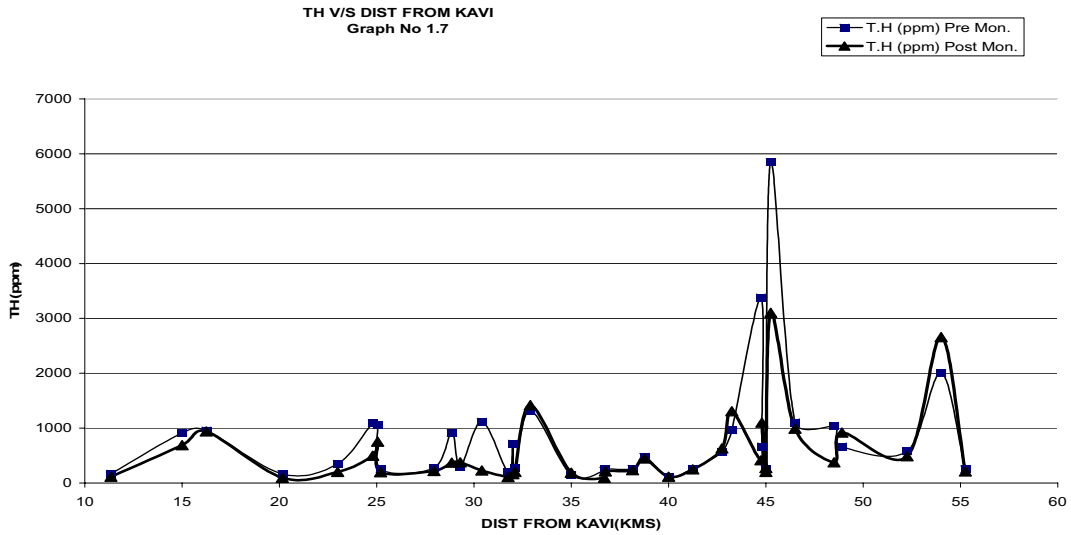
Graph 1.4. Chlorides v/s Distance from Kavi



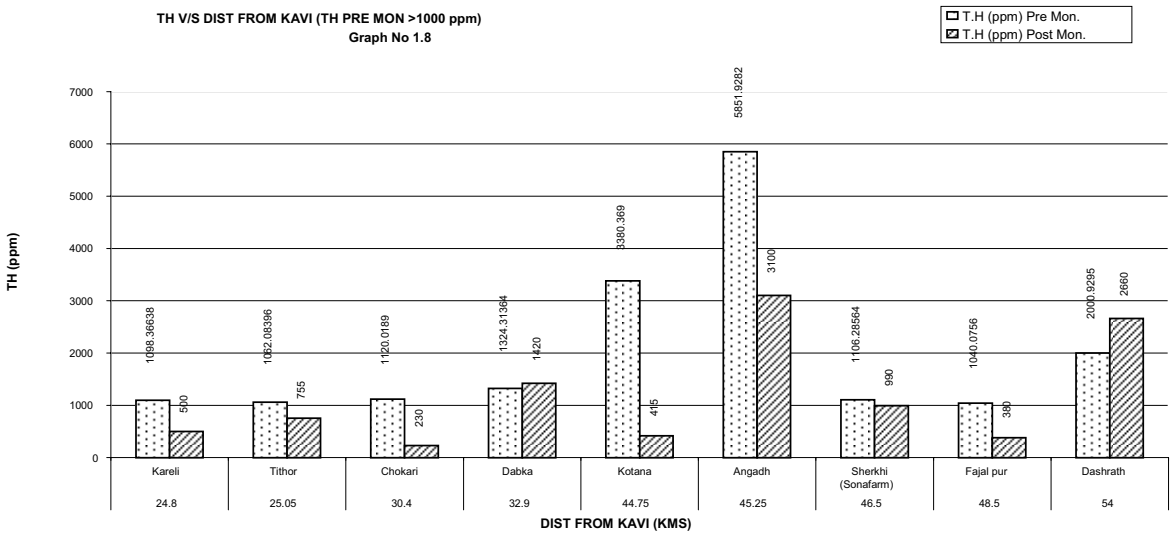
Graph 1.5. Chlorides v/s Distance from Kavi (Pre-Monsoon CI>3000ppm)



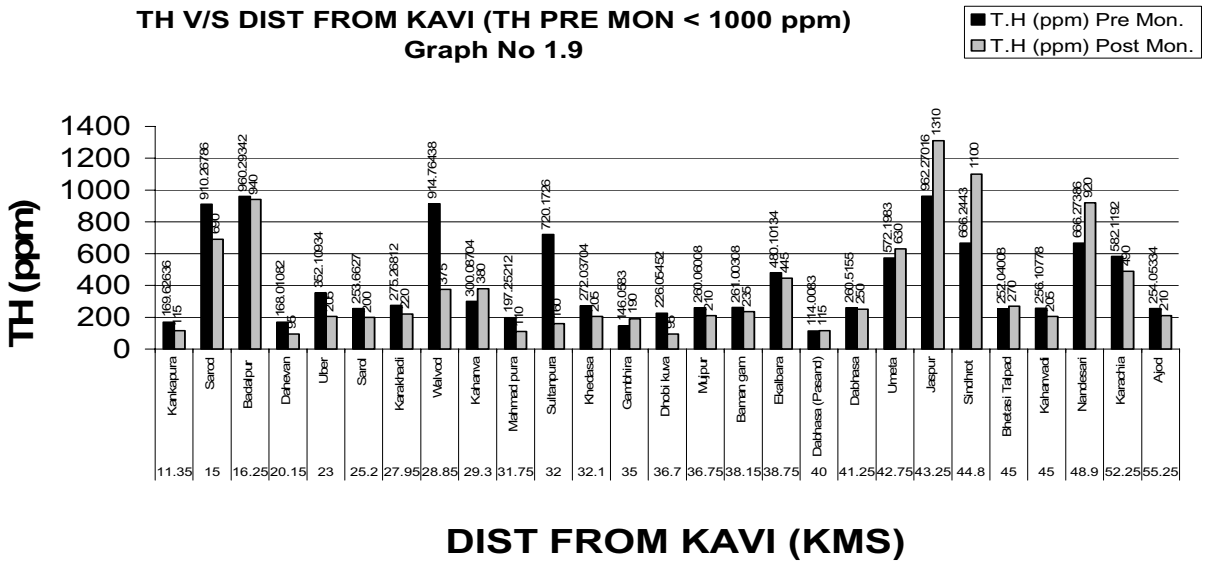
Graph 1.6. Chlorides v/s Distance from Kavi (Pre-Monsoon Cl < 3000 ppm)



Graph 1.7. Total Hardness v/s Distance from Kavi



Graph 1.8. Total Hardness v/s Distance from Kavi (Pre-Monsoon TH>1000ppm)



Graph 1.9: Total Hardness v/s Distance from Kavi (Pre-Monsoon TH < 1000 ppm)

Conclusions

Based on results obtained from chemical analysis of water samples following conclusions are drawn.

I. Considering Distances from Kavi Town

For T.D.S.:

Village	Distance from Kavi km.	T.D.S. in p.p.m.	
		Pre-monsoon	Post-monsoon
Sarod	15	8472	4436
Kareli	24.8	13036	2074
Dabka	32.9	8076	6442
Kotana	44.75	35414	1978
Angadh	45.25	20612	10312

1. From table and graphs for pre-monsoon and Post-monsoon results of T.D. S., it is observed that as the distance from Kavi Town increases, the T.D.S. values decreases of ground water samples. The high pre-monsoon values of the T.D.S. get normalized after the Post-monsoon period because of the rain water recharge and dilution with the high T.D.S. water.

2. Very high values of T. D. S. for pre-monsoon of ground water samples of distances of 44.75 and 45.25 km. Of Kotana and Angadh observed are 35414 p.p.m. and 20,612 p.p.m. This may be because of their locations very nearer to river and the effect of Tidal water. Minimization of flow is observed in river due to construction of dams, weirs and many French wells are constructed in river for withdrawal of water by Industries and Vadodara Municipal Corporation. Also this is highly intensified agricultural area. Many tube wells are located in this area and due to high withdrawal of ground water a vacuum in the aquifer may be created and resulted into sea water intrusion. Upconing of ground water during pumping may be the main cause of high T.D.S. values. The post-monsoon values of T.D.S. decreased more at the Kotana as compared to Angadh. This may be due to less depth of tube well at Kotana compared to Angadh. Another possible

reason may be because of local geological formations.

3. It was also seen that the pre-monsoon T.D.S. values of groundwater samples of Sarod, Kareli and Dabka at 15, 24.8 and 32.9 km. Distances from Kavi are 8472 p.p.m., 13036 p.p.m. and 8076 p.p.m. The high T.D.S. values of Sarod and Kareli ground water samples may be due to their location near Kavi and they are in Jambusar Taluka, which is nearer to the bay of Khambhat. All the tube wells in Jambusar taluka are affected by sea water intrusion. Kareli is at more distance from Kavi as compared to Sarod but the high T.D.S. is observed at Kareli. The probable reason may be due to over withdrawal of ground water or may be due to local geological formation. At Dabka, value of T.D.S. decreased compared to Sarod as Dabka is 17.90 km. away on u/s from Sarod. The post-monsoon T.D.S. values decreased more at Kareli as compared to Sarod. This may be due to the effect of rainfall recharge dilution and their location from Kavi. The decrease in T.D.S. value at Dabka is less compared to Sarod and Kareli. This may be due to local.

II. For Cl:

Village	Distance	Cl in p.p.m.	
	from Kavi km.	Pre-monsoon	Post-monsoon
Tithor	25.05	7747.59	2374.26
Dabka	32.9	7197.76	2924.09
Kotana	44.75	15995.07	909.72
Angadh	45.25	14995.3	6697.92

1. From table and graphs for pre-monsoon and post-monsoon results of Cl, it is observed that as the distance from Kavi town increases the Cl values decreases of ground water. The high pre-monsoon values of the Cl get decreased after the post-monsoon period because of the rainwater recharge.

2. High values of Cl for pre-monsoon of ground water samples of Kotana and Angadh are observed. The higher Cl value observed at Kotana compared to Angadh similar to T.D.S. values. The post-monsoon values of Cl decreased more at Kotana as compared to Angadh. This may be for same reasons as mentioned in I (2).

3. It was also seen that the pre-monsoon Cl values of ground water samples of Tithor and Dabka at 25.05 and 32.90 km distances from Kavi are 7747.59 p.p.m. and 7197.76 p.p.m. The Cl value is decreases at Dabka as compared to Tithor as the Dabka is far away from Tithor by 7.85 km u/s. Another possible reason may be Tithor is located on the bank of river where effect of river meandering to prove high amount of Cl in ground water. The post-monsoon values of Cl decreased. The decrease in Cl value at Dabka is less compared to Tithor. This may be due to local geological formations.

III For TH:

Village	Distance	TH in p.p.m.	
	from Kavi km.	Pre-monsoon	Post-monsoon
Kotana	44.75	3380.37	415
Angadh	45.25	5851.93	3100

1. From table and graphs for pre-monsoon and post-monsoon results of TH, it is observed that.

2. As the distance from Kavi town increases the TH values varying of ground water samples and so no clear relation can

be predicted. The high pre-monsoon values of the TH decreased after the post-monsoon. The high pre-monsoon values of the TH decreased after the post-monsoon period because of the rain water recharge.

3. High values of TH for pre-monsoon of ground water samples of Kotana and Angadh are observed. The high value of pre-monsoon TH at Kotana compared to Angadh is observed. The post-monsoon TH values decreased much more at Kotana as compared to Angadh. This is similar to variation of T.D.S. and Cl at above stations. This may be for same reasons as mentioned in I (2).

IV The values of pre-monsoon and post-monsoon T.D.S. of ground water samples of villages located on right bank of river are observed less compared to the villages on left bank of river. This may be due to irrigation by MRBC from Wanakbori weir on right bank of Mahi River.

Recommendations

- The government of Gujarat should construct more tidal regulator-cum-recharge structures to prevent surface salinity ingress as well as to recharge the surrounding land.
- Structures like check dams should be constructed to recharge ground water reservoirs.
- Withdrawal of the ground water used for irrigation should be restricted in the affected area for these framers should be initiated to use drip and sprinklers irrigation methods, so that saving of water.

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