RESULTS AND DISCUSSIONS

7 RESULTS AND DISCUSSIONS

In this chapter results of regression analysis, lab analysis and graphical analysis are presented along with discussions on it. The results and discussions from model simulation are included in chapter-5.

7.1 Results, Discussions on Regression & Graphical Analysis

(i) It is observed from graph 6.1 to 6.3 that Total Dissolved Solids (TDS) decreases with increased distance from Kavi where Mahi River merges in the Gulf of Cambay. It is also observed from graph 6.4 to 6.8 that TDS decreases with increasing distance from centre line of river.

(ii) The correlation coefficient r is a useful measure of the goodness of regression, commonly used to study the degree of statistical relationship between a set of variables. From Table 6.1, for graphs 6.1, 6.2, 6.5 & 6.6 the linear regression equations show that the correlation coefficient r is ranging between -0.76531 to -0.9144 which indicates a close negative linear correlationship between dependent variable TDS of groundwater (Y) and independent variable, distance from centre line of river or distance from Kavi where Mahi River merges in the Gulf of Cambay (X). An increase in the distance from centre line of river or distance from Kavi is associated with a proportional decrease in the value of TDS of groundwater. Similarly for graphs 6.3, 6.4 and 6.8 the linear regression equations show that the correlation coefficient r is ranging between -0.47757 to -0.57346 which indicates an average negative linear correlationship between the above two variables. It is also found from regression equation of graph 6.7 that the correlation coefficient r is -0.30779 which indicates poor negative linear correlationship between the above two variables. The dependent variable TDS of groundwater is not significantly influenced by the independent variable, distance from centre line of river or distance from Kavi only. So perfect match is not indicated and analysis by multiple linear regressions with additional independent variables is required. Standard error of estimate S_{YX} is a measure of scatter about the best fit

regression line of TDS of groundwater (Y) on distance from centre line of river or distance from Kavi (X). Its value is found ranging from 292.883 ppm to 4529.622 ppm

(iii) The multiple linear regression equations for estimating a dependent variable TDS for groundwater (X_1) from two independent variables, distance from Kavi (X_2) and reduced water level (X_3) for left bank of River Mahi of study area are represented in table 6.2. The multiple correlation coefficient $r_{1\,23}$ between the dependent variable TDS of groundwater (X_1) and two independent variable, distance from Kavi (X_2) & reduced water level (X_3) is found from partial correlation coefficients which uses the standard deviation of X_1 and X_2. The value of $r_{1.23}$ lies between 0 & 1. It is found from table 6.2 that for the multiple linear regression equations the value of multiple correlation coefficient $r_{1\,23}$ is ranging between 0.898 to 0.999 which indicates a close linear correlationship of (X_2) and (X_3) on (X_1). The table 6.2 shows the value of standard error of estimate $S_{1.23}$ of X_1 with respect to X_2 and X_3 for the multiple linear regression equations is ranging between 268.70 ppm to 1039.72 ppm for left bank.

(iv) The multiple linear regression equations for estimating a dependent variable TDS for groundwater (X_1) from two independent variables, distance from Kavi (X_2) and reduced water level (X_3) for right bank of River Mahi of study area are represented in table 6.3. It is found from table 6.3 that for the multiple linear regression equations the value of multiple correlation coefficient $r_{1\,23}$ is ranging between 0.916 to 0.9996 which indicates a close linear correlationship of (X_2) and (X_3) on (X_1). The table 6.3 shows the value of standard error of estimate $S_{1\,23}$ of X_1 with respect to X_2 and X_3 for the multiple linear regression equations is ranging between 200.79 ppm to 1298.91 ppm for right bank.

(v) The multiple linear regression equations for estimating a dependent variable TDS for groundwater (X_1) from two independent variables, distance from Kavi (X_2) and reduced water level (X_3) for both banks of River Mahi of study area are represented in table 6.4. It is found from table 6.4 that for the multiple linear regression equations the value of multiple correlation coefficient $r_{1\,23}$ is ranging between 0.816 to 0.994 which indicates a close linear correlationship of (X_2) and (X_3) on (X_1). The table 6.4 shows the value of standard error of estimate $S_{1\,23}$ of X_1 with respect to X_2 and X_3 for the

multiple linear regression equations is ranging between 317.95 ppm to 839.95 ppm for both banks.

(vi) The multiple linear regression equations for estimating a dependent variable TDS for groundwater (X_1) from three independent variables, distance from Kavi (X_2), reduced water level (X_3) and rainfall (X_4) for both banks of River Mahi of study area are represented in table 6.5. It is found from table 6.5 that for the multiple linear regression equations the value of multiple correlation coefficient $r_{1\,234}$ is ranging between 0.915 to 0.999 which indicates a close linear correlationship of (X_2), (X_3) and (X_4) on(X_1). The table 6.5 shows the value of standard error of estimate $S_{1\,234}$ of X_1 with respect to X_2, X_3 and X_4 for the multiple linear regression equations is ranging between 364 ppm to 777 ppm for both banks.

(vii) It is observed from Graphs 6.9 to 6.14, that impact of rainfall on TDS is inversely proportional i.e. high value of rainfall shows less value of TDS and less value of rainfall shows high values of TDS for different taluka in Mahi estuarine area

7.2 Results, Discussions on Lab as well as Graphical Analysis

Results obtained in the laboratory are recorded in table 6.6. These laboratory results are also represented graphically as TDS, Cl and TH V/S distance from Kavi and distance from centre line of Mahi River to see at a glance the change of groundwater quality in Mahi estuarine area in pre –monsoon and post- monsoon. Based on results obtained from chemical analysis of water samples following discussions and conclusions are made.

7.2.1 Considering Distances from Kavi (Sea) in Mahi Estuarine Area

For TDS:

Table 7.1 Measured TDS of Mahi Estuarine Area (Distance from Kavi) For the Year 2003

Village	Distance from Kavi (km)	TDS in ppm	
		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 6.6 and graphs for pre-monsoon & Post-monsoon results of TDS, it is observed that as the distance from Kavi town increases, the TDS values decreases of ground water samples.

   The high pre-monsoon values of the TDS get normalized after the post-monsoon period because of rain water recharge and dilution with the high TDS water.

2. From Table 7.1 and graphs 6.15, 6.16 & 6.17 for pre-monsoon & Post-monsoon results of TDS, it is observed that very high values of TDS for pre-monsoon of groundwater samples at distances of 44.75 and 45.25 km of Kotana and Angadh observed are 35414 ppm and 20,612 ppm. 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 construction of many French wells in Mahi River by Industries and Vadodara Mahanagar Seva Sadan for withdrawal of water. Also this is highly

intensified agricultural area. Many 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. Upcoming of groundwater during pumping may be the main cause of high TDS values.

The post-monsoon values of TDS 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 local geological formations.

3. It was also seen that the pre-monsoon TDS values of groundwater samples of Sarod, Kareli and Dabka at 15, 24.8 and 32.9 km distances from Kavi are 8472 ppm, 13036 ppm and 8076 ppm. The high pre-monsoon TDS values of groundwater samples of Sarod and Kareli as compared to Dabka are observed. This may be due to their location near Kavi (Sea) and they are in Jambusar taluka, which is nearer to the bay of Khambhat. All the wells in Jambusar taluka are affected by sea water intrusion. Kareli is at more distance from Kavi as compared to Sarod but the high TDS is observed at Kareli. The probable reason may be due to over withdrawal of groundwater or may be due to local geological formation. At Dabka, value of TDS decreased compared to Sarod as Dabka is 17.90 km away on upstream from Sarod.

   The post-monsoon TDS values decreased more at Kareli compared to Sarod. This may be the effect of rainfall recharge dilution and their location from Kavi. The decrease in TDS value at Dabka is less compared to Sarod and Kareli. This may be due to local geological formation.

For Cl:

Table 7.2 Measured Cl of Mahi Estuarine Area (Distance from Kavi) for the Year 2003

Village	Distance from Kavi (km)	Cl in ppm	
		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 6.6 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 rain water recharge.
2. From Table 7.2 and graphs 6.18, 6.19 & 6.20 for pre-monsoon and post-monsoon results of Cl, it is observed that high values of Cl for pre-monsoon of ground water samples of Kotana and Angadh at 44.75 km and 45.25 km distances from Kavi are 15995.07 ppm & 14995.3 ppm. The higher Cl value observed at Kotana compared to Angadh similar to TDS values variation.
   The post-monsoon Cl values decreased less at Angadh as compared to Kotana similar to TDS decreased. This may be for the same reasons as mentioned for high TDS of groundwater samples at Kotana and Angadh considering distances from Kavi.
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 ppm and 7197.76 ppm. The Cl value is less at Dabka as compared to Tithor as the Dabka is far away from Tithor by about 7.85 km upstream. 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.

For TH:

Table 7.3 Measured TH of Mahi Estuarine Area (Distance from Kavi)

for the Year 2003

Village	Distance from Kavi (km)	TH in ppm	
		Pre-monsoon	Post-monsoon
Kotana	44.75	3380.37	415
Angadh	45.25	5851.93	3100

1. From table 6.6 and graphs for pre-monsoon and post-monsoon results of TH, it is observed that as the distance from Kavı town mcreases 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 period because of the rain water recharge.
2. From table 7.3 and graphs 6.21, 6.22 & 6.23 for pre-monsoon and post-monsoon results of TH, it is observed that values of TH for pre-monsoon of groundwater samples of Kotana and Angadh are high. The high value of pre-monsoon TH at Kotana decreased much more compared to Angadh is observed after monsoon. This is similar to variation of TDS and Cl at above stations.
   This may be for the same reasons as mentioned for high TDS of groundwater samples at Kotana and Angadh considering distances from Kavi.

7.2.2 Considering Distances from Mahi River in Mahi Estuarine Area.

For TDS:

Table 7.4 Measured TDS of Mahi Estuarine Area (Distance from River) for the Year 2003

Village	Distance from River km	TDS in ppm	
		Pre-monsoon	Post-monsoon
Kotana	0.65	35414	1978
Angadh	0.70	20612	10312
Dabka	2.50	8076	6442
Sarod	3.30	8472	4436
Kareli	5.15	13036	2074

1. From Table 6.6 and graphs for pre-monsoon and post-monsoon results of TDS, it is observed that as the distance from river increases the TDS values decreases of ground water samples.
   The high pre-monsoon values of the TDS gets diluted after the post-monsoon period because of the rain water recharge and may be due to recharge of the flooded river water.

2. From table 7.4 and graphs 6.24, 6.25 and 6.26 for pre-monsoon and post-monsoon results of TDS, it is observed that very high values of TDS for pre-monsoon of groundwater samples at distances from river 0.65 km and 0.70 km of Kotana and Angadh are 35414 ppm and 20,612 ppm. The post-monsoon values of TDS decreased less at Angadh. This may be for the same reasons as mentioned for high TDS of groundwater samples at Kotana and Angadh considering distances from Kavi (Sea).
3. It was also seen that the pre-monsoon TDS values of groundwater samples of Dabka, Sarod and Kareli at 2.50, 3.30 and 5.15 km distances from river are 8076 ppm, 8472 ppm and 13036 ppm. The high pre-monsoon TDS values are at Sarod and Kareli as compared to Dabka. The post-monsoon TDS values decreased more at Kareli compared to Sarod. This may be for the same reasons as mentioned for high TDS values of groundwater samples at Sarod, Kareli and Dabka considering distances from Kavi (Sea). The decrease in TDS value at Dabka is less compared to Sarod and Kareli as Dabka is 17.90 km away on upstream from Sarod and 8.1 km on upstream from Kareli. This may be due to local geological formation. The decrease in post-monsoon TDS value is less compared to Sarod and Kareli. This may be due to local geological formations.

For Cl:

Table 7.5 Measured Cl of Mahi Estuarine Area (Distance from River)

for the Year 2003

Village	Distance from River in km	Cl in ppm	
		Pre-monsoon	Post-monsoon
Kotana	0.65	15995.07	909.72
Angadh	0.70	14995.3	6697.92
Dabka	2.5	7197.76	2924.09
Sarod	3.3	5248.37	2199.32
Tithor	4.0	7747.59	2374.26
Kareli	5.15	5498.29	1099.66
Badalpur	5.75	4398.63	2149.33

1. From Table 6.6 and graphs for pre-monsoon and post-monsoon results of Cl, it is observed that as the distance from river increases the Cl values decreases of ground water samples.

   The high pre-monsoon values of Cl get diluted after the post-monsoon period because of the rain water recharge, and may be due to recharge of the flooded river water.

2. From Table 7.5 and graphs 6.27, 6.28 and 6.29 for pre-monsoon and post-monsoon results of Cl, it is observed that the pre-monsoon Cl values of groundwater samples of Kotana and Angadh at 0.65 km and 0.70 km distances from river are 15995.07 ppm and 14995.3 ppm. They are very high. The higher Cl value observed at Kotana compared to Angadh similar to variation of TDS for pre-monsoon for above stations. The post-monsoon Cl values decreased less at Angadh similar to TDS decrease. This may be for same reasons as mentioned for high TDS of groundwater samples at Kotana and Angadh considering distances from Kavi.

3. Similarly, it was also seen that the high pre-monsoon Cl values of groundwater samples at Dabka, Sarod, Tithor, Kareli and Badalpur. The pre-monsoon Cl value is higher at Tithor as compared to Sarod; the reason may be meandering of river at Tithor and may be due to local geological formation. The post-monsoon Cl values at Tithor are higher as compared to Sarod. This may be for the same reasons as mentioned for high pre-monsoon Cl values of groundwater samples at Tithor and Sarod considering distances from Kavi. Similarly, at Badalpur Cl value is higher as compared to Kareli may be due to Badalpur is at 16.25 km from Kavi and Kareli is at 24.8 km from Kavi.

For TH:

Table 7.6 Measured TH of Mahi Estuarine Area (Distance from River)

for the Year 2003.

Village	Distance from River km	TH in ppm	
		Pre-monsoon	Post-monsoon
Kotana	0.65	3380.37	415
Angadh	0.70	5851.93	3100

1. From table 6.6 and graphs for pre-monsoon and post-monsoon results of TH, it is observed that as the distance from river increases the TH values varying of ground water samples and so clear relation cannot be predicted.
   The high pre-monsoon values of TH decreased after the post-monsoon period for most of ground water samples because of the rain water recharge.

2. From Table 7.6 and graphs 6.30, 6.31 and 6.32 for pre-monsoon and post-monsoon results of TH, it is observed that values of TH for pre-monsoon of groundwater samples of Kotana and Angadh are high. The post-monsoon TH values decreased much more at Kotana as compared to Angadh are observed. This is similar to variation of TDS and Cl at above stations. This may be for the same reasons as mentioned for high TDS of groundwater samples at Kotana and Angadh considering distances from Kavi.

. 7.2.3 Considering Location of Villages on Right or Left Bank.

The values of pre-monsoon and post-monsoon TDS 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.