CONCLUSIONS

8 CONCLUSIONS

In this chapter summary, conclusions and research contribution of the present study are discussed.

8.1 Summary

The present study is related to groundwater fluctuations in Mahi estuarine area which is laying in part of three districts of Gujarat namely Anand, Vadodara, and Bharuch. The tidal effect of sea in the Mahi estuary has increased the sea water intrusion in the land ward side. The groundwater has been contaminated over the period and the quality of the ground water is continuously deteriorating. Major portion of this area is comprises agricultural land. The groundwater system of this area is dynamic in nature because of monsoon recharge due to rain, irrigation return flow and groundwater pumping. The water level and water quality are also affected by natural recharge of surface water of River Mahi.

The present study attempts modeling of groundwater regime in the study area. The groundwater system of the study area is characterized by using inverse modeling and aquifer hydraulic conductivity values are obtained. The groundwater fluctuations are obtained during study period using model simulation. Mass balance of surface water and groundwater of unconfined aquifer is computed. The effect of fresh water pool, created by construction of weir, on adjoining groundwater table is investigated. The relation between salinity and distance from sea are obtained. Water quality of unconfined aquifer is studied with reference to natural recharge from river. Finally predictions are made for effect of alternative locations of weir on recharge of estuary area.

8.2 Conclusions

Based on results and discussions following conclusions are derived.

(i) General geology confirm to alluvial area consisting alternate layers of clay, sand, gravel, occasionally mixed with kankar. Such strata are suitable for artificial recharge of groundwater.

(ii) In conceptual model number of zones considered for horizontal permeability and specific yield are considered 23 which may be adequate to represent the variation in aquifer characteristics in the study area.

(iii) The calibration of model is carried out using data from the period June 1997 to June 1999 and the horizontal permeability is found to be in the range of 5 to 50 m/day.

(iv) The calibrated values are finalized by comparing the observed and computed groundwater level at various well locations. There is a very good match between the computed and observed heads in most of wells of the study area under validation.

(v) Higher water table is observed at north-east where as water level reduces towards west boundary. The contours of groundwater level are obtained for pre and post monsoon, General groundwater flow is found from north-east to south-west direction. Groundwater profiles are obtained across river. In each profiles mound below river is observed. The unsymmetrical behavior in the groundwater mounds along the centre line of river is reflected in Figures 5.11 to 5.15 because on right hand side irrigation return flow is adding into the groundwater in MRBC area where as in left hand side irrigation is done by groundwater pumping.

(vi) The weirs are introduced as low permeability cells in unconfined aquifer. Length of Badalpur weir is more than Sindhrot weir. Hence area of influence is more at Badalpur weir as compared to Sindhrot weir.

(vii) Construction of the weir has resulted in increase in the groundwater recharge due to fresh surface water seepage in the study area and also helps in reducing salinity. Reduced water levels in unconfined aquifer are found to be showing rising trend with weir compared to without weir condition. Introduction of weir cause more recharge in nearby area. Increase in water table at nearby locations in two years after construction of Sindhrot weir is found and it is raised by 0.5 m to 1.43 m.

(viii) Water levels in locations surrounding of Sindhrot weir are not much affected by Badalpur weir. As Badalpur weir is located sufficiently downstream of Sindhrot weir.

(ix) Water quality analysis is carried out to find effect of distance from surface water. The Total Dissolved Solids (TDS) of ground water decreases with increasing distance from sea (Kavi) where Mahi River merges in the Gulf of Khambhat (Cambay). Similar trend is observed from centre line of river.

(x) The correlation coefficients obtained from linear regression equations indicates close, average and poor negative linear correlationship between dependent variable TDS of groundwater and independent variable, distance from centre line of river or distance from sea (Kavi).

(xi) The correlation coefficient 'r' for multiple linear relations between TDS of groundwater and two parameters i. e. distance from sea (Kavi) and Reduced Water Level (RWL) for left bank, right bank and both banks are found well within the range. The correlation coefficient 'r' for multiple linear relations between TDS of groundwater and three parameters i. e. distance from sea (Kavi), Reduced Water Level (RWL) and rainfall for both banks are found well within the range.

(xii) It is concluded from graphical analysis 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

(xiii) Attempt is made to get relationship among parameters like TDS, RWL, distances from sea (Kavi) and rainfall but no clear relationship is obtained because of the complexity of the system in Mahi estuarine area.

(xiv) The pre-monsoon and post-monsoon TDS and Cl values of groundwater samples of Mahi estuarine area decreases as the distances from sea (Kavi) or river increases. The pre-monsoon and post-monsoon TH values of groundwater samples of Mahi estuarine area varying as the distances from sea (Kavi) or river increases. So, no clear relation can be predicted.

(xv) The high pre-monsoon values of the TDS, Cl and TH of groundwater samples of Mahi estuarine area get normalized after the post- monsoon period because of the rainfall recharge. This may be also due to recharge of the flooded river water.

(xvi) The very high values of TDS for pre-monsoon of groundwater samples of Kotana and Angadh are observed. 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.

(xvii) The high pre-monsoon TDS values of groundwater samples at 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 sea (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.

(xviii) 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.

8.3 Research Contributions

1. The problem of salinity and water level fluctuations in study area is identified and the extent of area affected is found based on field data collection.
2. The conceptual groundwater model is developed with Mahi River as major recharge features. The depth and extent of unconfined aquifer is estimated based on bore log data.
3. Groundwater Model is constructed for study area and boundary conditions are worked out.
4. Zoning of study area is done for the aquifer parameter and inverse modelling is carried out. The aquifer hydraulic conductivity values are obtained.
5. Field samples are collected and water quality analysis is carried out and water quality parameters are found.
6. Regression analysis is carried out and the linear regression equations are developed to predict the groundwater quality.

7. Monsoon and non-monsoon recharge due to rainfall, surface water and irrigation is estimated based on the water table fluctuation method.
8. Groundwater Model simulation is carried out for without weir and one/ two weir scenarios.

Scope of Further Study

The study can be extended to extend the model area to include Sardar Sarovar Command to investigate consumptive use of surface water and groundwater for irrigation.