Seventh Chapter
CHAPTER 7

WATER MANAGEMENT STRATEGIES IN THE MATAR BRANCH COMMAND AREA OF MRBC

7.1 Introduction

Water-logging and soil salinization are the major issues in irrigated areas in almost all the canal command areas in India. The conjunctive water use planning is necessary for the optimal water resources management in context of controlling water-logging in command areas. It is observed that a spatio-temporal imbalance in water demands and natural supplies exists at most places. The period of lowest natural water supplies generally coincides with the largest demand. In India, future demands for water cannot be met entirely from new surface reservoirs and maximum groundwater development can only be obtained by conjunctive use of groundwater and surface water reservoirs (Murty, 1990). Viswanadh and Reddy (1994) examined a suitable mix of groundwater and surface water for their conjunctive use in different regions of Krishna Delta and an appropriate average mix of groundwater and surface water of 28:72 was suggested. A large amount of surface water can be conserved at Nagarjuna Sagar reservoir by this approach.

The present study of integrated water resources development and management strategies in Matar branch canal command area is carried out in four different parts: Hydrological studies of the area, Performance evaluation of the canal system, Geostatistical analysis of the groundwater levels and Groundwater flow modeling. The hydrological studies dealt with the analysis of the rainfall data and its trends, estimation of crop evapotranspiration, agro-climatic analysis and the hydrological impacts on the crop cultivation practices in the area. The performance of the existing canal system is assessed using Performance Indicator to incorporate this aspect in management process.
The groundwater levels and aquifer properties can be considered as a regionalized variable with spatial distribution structure. Semi-variogram modeling and geostatistical analysis in GIS environment is performed to generate thematic data layers for the groundwater levels, a very vital input parameter for the groundwater flow modeling, in the study area. The estimation of the groundwater potential in the canal command area will help in the planning for the use of groundwater in conjunction with the canal water supplies for the irrigation requirements. A groundwater model is developed to budget the groundwater resources and determine the safe aquifer yield to incorporate the uncertainties in the annual rainfall.

7.2 Water resources management strategies for the command area

The more efficient management of available water resources in a region is recognized from the fact that the future water demands will exceed the natural supply. In the research study presented here, some aspects of integrated water resources development in the canal command area are dealt with. It has provided the insight to the scientific approach for the development of water resources in canal irrigated areas. The results of hydrological analysis and groundwater flow modeling need to be incorporated for the effective utilization of the available water resources in the area. Different water resources management strategies for the Matar branch canal command area in MRBC project are discussed hereunder:

7.2.1 Change in the cropping pattern

The rainfall trend analysis in the Matar branch area shows that the annual rainfall has decreasing nature while the number of rainy days with heavy rainfall is increasing. The heavy rainfall events in the canal command area may result in the flooding of agriculture fields. The crops which are sensitive to continuous contact of water can not be grown in these conditions. Under such situations the crops with less water requirements and susceptible to water accumulation e.g. tobacco (*Nicotiana tabacum*) and cotton (*Gossypium spp.*), shall be replaced by the crops with high water requirements. Paddy (*Oryza sativa*) has high crop evapotranspiration requirements and also need stagnant
water to a depth of about 10cm in the fields. Thus, paddy is the better choice under the conditions of heavy rainfall events during Kharif season.

The intensive irrigation for long time has resulted in the situation of high water table levels. Average depth to water level in the study area observed during pre-monsoon condition is about 6m while for the post-monsoon condition; it is about 4.5m (Fig. 6.1). There are some parts in the area where depth to water level is observed between 2-3m. The high water table situation is not favorable for the crops with less water requirements. The growth and yield of the crops susceptible to such conditions are influenced. The crops with high water requirements e.g. Paddy (*Oryza sativa*) and sugarcane (*Saccharum officinarum*) grow in usual way under such circumstances. Looking into the limited availability of market for sugarcane crop in the nearby area (No sugar factory is located in the Kheda district) and large number of rice mills located in the district for paddy processing, it is advisable to cultivate paddy crop for the farmers during Kharif season.

The tail reach area of the canal command has the frequent short supply of the canal water. The yield of the crop like paddy would suffer if alternative source of irrigation water does not exist. The crops like maize (*Zea mays*), bajra (*Pennisetum americanum*) and fodder have less water requirements and shall be grown.

### 7.2.2 Adjustment in the crop calendar

The Performance analysis of the Matar branch canal using Performance Indicator revealed ([Article 4.6.3](#)) that transplantation of paddy crop shall be done earlier than its normal practice of transplantation in the area. The paddy transplantation performed during July 1-15 results in better performance of the canal system. This is due to the better utilization of the rainfall when the paddy crop transplantation is pre-poned. The dependence of the paddy crop for its water requirements on canal supplies or other sources seems to be reduced with the additional availability of the rain water in the early stage of the crop. Thus, adjustment in the crop planting dates ultimately helps in the management of the water resources.
7.2.3 **Conjunctive use of water**

The groundwater flow model is developed for the study area and the groundwater balance estimation from the model simulation showed that there is a good potential for the groundwater development. The estimated average annual groundwater balance of 71.94 Mm$^3$ (Article 6.12.2) shall be utilized for the crop water requirements during the periods of deficit supplies from the canal. The rainfall data analysis for the area indicated the uncertainties in the annual rainfall. Depending on the annual rainfall during a year, it may be categorized as wet, average or dry hydrological year. The safe aquifer yields for wet, average and dry years are determined as 103 Mm$^3$/year, 91 Mm$^3$/year and 75 Mm$^3$/year respectively. The annual rainfall during a year may be referred to arrive at the available volume of the groundwater for irrigation. This available groundwater for the year is very significant for the conjunctive use of water in the area. The conjunctive use practice of surface water and groundwater would result in lowering down the water table levels which will ultimately prove to be an important step for preventing the water-logging conditions in the canal command area.

7.2.4 **Groundwater quality criteria**

The quality of groundwater is also important in the conjunctive use of the water for irrigation. Results of the salinity assessment in the MRBC command area shows that 91% of the area has the EC value exceeding 750 micromhos/cm and 59% area has EC value exceeding 2250 micromhos/cm. (Table 3.1). The groundwater may be mixed with the surface water for the irrigation. Another alternative can be the application of the canal water followed by the groundwater for the irrigation. The salinity of the agriculture fields can be controlled by the application of the gypsum dose. During the interactions with the farmers in the study area, it was found that some of the farmers are regularly using gypsum to maintain the fertility of their agricultural fields. Depending upon the severity of the land salinity, a regular dose of gypsum shall be applied by the farmers for the better crop productivity. Looking into the soil salinity, the salt tolerant crops shall be grown in the study area.
7.2.5 Water efficient methods of irrigation

Drip irrigation method results in considerable saving of the irrigation water and better crop yield. In the water deficit areas of semi-arid regions, such water efficient irrigation methods prove to be an ideal choice for water resources management. The farmers in the study area cultivate the crops like tobacco and vegetables in non-monsoon seasons. These types of crops can be conveniently irrigated using drip system. During the visits of the study area, it was noticed that some farmers have started practicing drip irrigation method in crop cultivation. It is also reported by the farmers in the questionnaire survey that the quality and yield of the crop improves with the drip irrigation method. Though, paddy crop cannot be irrigated using drip or sprinkler due to its large water requirements.

7.2.6 Increasing aquifer pumping

The annual groundwater budget for the Matar branch canal command area obtained from the groundwater modeling shows that there is a groundwater surplus every year. The irrigation water deficit arising in the area can be met with from the groundwater extraction. The present pumping rates of the groundwater can be increased by establishing the new wells or by increasing the pumping hours of the existing wells in the area. Madhya Gujarat Vij Company Ltd. (MGVCL), Vadodara manages the electrical power distribution in the area. In the recent time, a notification from the company has appeared for the new connections for power supply in agriculture sector as ‘on demand’ (Tatkal) basis. It shows the good opportunities for increasing the number of pumping wells for the irrigation water requirements.

The farmers would also like to reduce the dependence on uncertain canal water supplies. There are about 1270 wells existing in the study area. The calibrated-validated groundwater model shows the pumping of 76 Mm$^3$/year of water. For the average annual groundwater surplus of 71.94 Mm$^3$, there are additional 1000 wells required. The availability of the electrical power, higher levels of groundwater table and advancement in the well drilling technology provides better prospects for additional pumping wells for the agriculture sector. The electric power supply for agriculture sector is eight hours a day, as decided by the GOG. The pumping hours of the existing wells can also be
increased for the crop water requirements in the command area, provided the daily electric power supply hours is increased by the GOG.

The safe aquifer yields are determined by using the developed groundwater model for wet, average and dry years as 103 Mm$^3$/year, 91 Mm$^3$/year and 75 Mm$^3$/year respectively. Based on the annual rainfall observed during a year, it is referred to as wet, average or dry year. The safe aquifer yield value for the corresponding year shall be taken into consideration to decide the aquifer pumping for that water year.

### 7.2.7 Canal lining

It is observed that large amount of irrigation is lost through seepage from unlined canals. Apart from the branch canal, all the canals in the study area are unlined, leading to the loss of irrigation water. It also results in rise of the water table levels. The agriculture fields adjoining to the canal are found with the accumulated seepage water from the canals. Lining of the canal network would not only help conserving the water for irrigation but reduce the risk of water-logging in the command area to a certain extent. It may be noted that the 18 km long Traj distributary canal of the Matar branch canal network is recently provided with lining during March-June, 2013. This would help in controlling of the canal seepages in the tail reach area of the command. The increased flow velocity in the canal will also result in the timely supply of the irrigation water. It is also recommended that the minor and sub-minor canals of the Matar branch canal shall be lined at the earliest.

### 7.2.8 Improvement in drainage system

One of the reasons for the rise in groundwater table levels in the command area is poor drainage system causing rainfall, canal seepages and irrigation return flows to accumulate. There are surface drains in the area created and managed by the irrigation department. There are bottlenecks and obstructions observed in these drains and it needs regular and proper maintenance to carry the design flows. The topography of the study area does not permit the natural drainage of the rainfall and areas near Garmal and Machhiel villages remain with accumulated rain water for a long time even after the monsoon period. The existing network of artificial drains shall be regularly maintained to
carry the designed flow of the runoff during monsoon period. The drains shall be kept clean to allow the irrigation return flow from the fields and the residual flow from the tail canals.

### 7.2.9 Training of stakeholders

Training is an integral part of any system. Irrigation system involves large number of the people, mostly less educated farmers, watchmen (*chowkidars*), supervisors and engineers. The success of water resources management largely depends on the perception of the stakeholders. Farmers are the major user of the water resources. They should be trained for the judicious application of irrigation water in the fields. WALMI, Anand is training the stakeholders and staff in irrigation department for the efficient use of water in agriculture. Regular training sessions shall be arranged for the farmers at village levels as well as at the research farms where the demonstrations of the efficient water application can be made. The officers of the irrigation department shall take a lead to organize such training schedules as a part of the water resources management programme.

The Anand Agriculture University, Anand houses various farms using scientific ways for the crop cultivation. One of its extension centres is located very near the Matar branch canal command area at Navagam, Ta. Matar. The centre is involved in the research activities related to paddy cultivation and new varieties of the paddy. Farmers shall be encouraged to regularly visit the farm for the visualization of the scientific ways of paddy farming. Such activities in the command area will definitely help in the management of the water resources.

### 7.3 Summary and Conclusions

The conjunctive water use practice will not only satisfy the deficit in crop water needs but will also help in controlling the rise of groundwater levels. It is found that increase in groundwater pumping as well as reduction in aquifer recharge is the better option for the development of water resources to meet with the deficit in crop water requirements. Groundwater pumping shall be increased by drilling new wells and/or increasing pumping from existing wells. The safe aquifer yields calculated for uncertainties in
rainfall will also be helpful to the government organizations and water resources development agencies in framing policies for the decision making for the groundwater development in the Matar branch canal command area of MRBC project in central Gujarat. The aquifer recharge can be reduced by controlling canal seepages and irrigation return flows. Various water resources management options suggested are groundwater pumping, canal lining, selection of water efficient irrigation methods, change in water pricing policy, change in cropping pattern, training of the stakeholders and a well established drainage system.