CHAPTER 8

CONCLUSION

This study has been conducted to develop optimal irrigation management strategies for the command area of the on-going Pagladiya Dam Project in Assam, India. A two stage irrigation management strategy has been applied for optimal allocation of the available water resources to the different crops grown in the command area. In the first stage, a monthly conjunctive irrigation management model has been formulated. A mathematical groundwater flow simulation model has been linked to the optimization model, so as to form a Linked Simulation-Optimization model. The computational burden associated with the LSO model, has been addressed by applying a novel approach of groundwater model simplification.

In the second stage, a Linear Programming problem of intra-seasonal crop water allocation has been formulated, with the objective of maximizing the sum of relative yield of all crops grown in the command area. The outputs of the first stage model have been used as inputs for the second stage model. An LP model namely, LINDO has been used to solve this problem.

In order to develop long term irrigation management strategies for the study area, optimization has been carried out at five different scenarios of the climatic variables. From the probability analysis of rainfall in the command area and inflow into the reservoir, five different optimization scenarios have been created at 10%, 30%, 50%, 70% and 90% probabilities of exceedence of these variables.
Finally, a search algorithm based on AIS has been formulated and then the same has been applied in the formulated optimization problems. The performances of this AIS algorithm have been evaluated in comparison with GA as well as the LP model.

Based on the methodology applied and the observation made, the following conclusions can be drawn:

1) Conjunctive use planning would be a very effective for irrigation management in the study area, for more than one reason. Firstly, it satisfies the crop water requirement in the study area in an assured way, at different climatic scenarios and also during different periods of the year. Secondly, it helps to depress the shallow groundwater table in the study area, which is quite prone to water logging. On the other hand, any possibility of groundwater depletion can also be avoided by the canal release, which contribute to groundwater recharge.

2) The objective function of minimizing the squared deficit from demand, as used in the monthly conjunctive use model, has been found to be the very effective, as it has prevented large irrigation deficit during any month and has distributed the deficits to different months of the year.

3) Genetic algorithm has been found to perform satisfactorily for deriving efficient conjunctive irrigation management strategies. The problem formulation was simple and by using the penalty function approach, a large number of constraints could be handled easily. Although the fitness values at different PE levels seem to be high in apparent look (Fig. 6.6), but the actual irrigation deficits (or surpluses) during different months at different PE levels are quite low, as evident from Tables 6.2 through 6.6. Further, a comparison between the estimated NIR values of crops (Tables 3.7 through 3.18) and the final irrigation depths allocated to different crops by the LP model (Tables 6.7 through 6.17), will reveal that the deficits are quite
negligible, except at 90% PE level which of course, represents extreme climatic scenario in the study area.

4) The new approach used for groundwater model simplification has been found to be quite effective in reducing the computational burden involved in the Linked Simulation-Optimization approach used in the monthly conjunctive use optimization model. Optimization with the simplified model has resulted in an eightfold reduction in computational time as compared to optimization with the original flow model developed in this study.

5) The formulated AIS algorithm has shown very encouraging results. The objective function values obtained from AIS, in respect of the monthly conjunctive use optimization model, are quite comparable to those obtained from GA (Fig. 7.4 through Fig. 7.7). In fact, AIS has outperformed GA at certain scenarios of optimization (Fig. 7.8). In respect of the crop yield maximization problem too, AIS and the LP model have both shown comparable results (Fig. 7.14). However, the convergence speed of the LP model has been found to be much higher than AIS. But nevertheless, the implementation of the AIS algorithm in programming platform like MATLAB, gives the algorithm various advantages in problem formulation such as input of the decision variables as well as the constraints in matrix and vector forms. Moreover, the LP model permits constraint violation in the order of $10^{-5}$. But no constraint violation is allowed in AIS, due to the penalty parameter approach used for handling the constraint set, as in the case of GA.

It can, therefore, be inferred that both GA and AIS can be successfully used for developing efficient conjunctive irrigation management policies and strategies.
8.1 SUGGESTIONS FOR FUTURE WORKS IN THE RELEVANT FIELD

Like all other conjunctive use study, this study too has certain limitations. Certain assumptions related to the reservoir, aquifer and crops were considered, so as to simplify the model development process.

Based on the observations made, the following suggestions are made for future works on conjunctive irrigation management in general and in the command area of Pagladiya Dam Project in particular.

i. The present study has considered minimization of the deficits in irrigation supply under a specific cropping pattern as the goal, while developing the conjunctive use plans. The cost aspects related to such management models have not been considered with the assumption that the preferences among the farmers of the study area, are more important than the net economic benefit from agriculture. However, an economic optimization may be considered to observe the trade-offs between pumping costs and net return from irrigated agriculture. But the shallow water table conditions in the study area must be paid due attention while formulating such models.

ii. The groundwater level contours used in this study, pertains to the year 1993. More recent data regarding the water table at various locations within the study area, if available, should be collected for adequate representation of the groundwater scenario in the study area. Moreover, the possible change in the boundary conditions along the Pagladiya river, after construction of the dam should also be assessed, while defining the boundary conditions in the groundwater flow model. Data regarding the actual number of tube wells in working conditions and the number and types of recharge structures present within the study, should also be collected.
iii. Although the groundwater model simplification process used in the present study has been found to be effective for the present study, the same method may be used in different types of aquifers, so as to ascertain the validity of such model simplification process.