

**INTEGRATED MULTILEVEL IRRIGATION
MANAGEMENT MODEL FOR
LOWER INDUS BASIN**

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in fulfilment of the requirements for
the award of
DOCTOR OF PHILOSOPHY*



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CERTIFICATE

This is to certify that the thesis entitled, 'INTEGRATED MULTILEVEL IRRIGATION MANAGEMENT MODEL FOR LOWER INDUS BASIN' being submitted by Mr. Abbas Ali to The Indian Institute of Technology, Delhi, India, for the award of the degree of DOCTOR OF PHILOSOPHY, is a record of bonafide research work carried out by him under my supervision and guidance. The thesis work, in my opinion, has reached the standard, fulfilling the requirements for DOCTOR OF PHILOSOPHY degree. The research report and the results presented in this thesis have not been submitted, in part or in full, to any other University or Institute, for the award of any degree or diploma.

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ABSTRACT

Several studies have dealt with the development of models for the conjunctive use of surface and groundwater. All these studies have addressed to various problems associated with the conjunctive use but none have studied the effects of adjustments in peak water requirements which can have significant impact on the cropping pattern.

In this study a two level optimization model has been developed to obtain the optimal cropping pattern considering the impact of variation in sowing dates on the peak water requirements. At the first level, a linear programming model is developed which optimizes the net return from the crops and depicts the optimal cropping pattern and monthly water withdrawals from canal and tube well for a given set of sowing dates. At the second level, an integer programming model has been developed for optimizing the sowing dates using linearized relationship between crop coefficient and percentage growing season. The sowing dates at the 1st level are then taken as the sowing dates obtained from the second level. The process is repeated till it converges. Two variation patterns for the crop area have been considered. In the first variation pattern the sowing date for a particular crop is kept the same, while in the other variation pattern the sowing date for the same crop is varied in different areas.

The coupling of groundwater hydraulics with surface water is not considered in the optimization model. However the interaction between surface water and groundwater is considered in the model by imposing a groundwater balance constraint on the groundwater withdrawals on annual basis. The optimum policy for pumping the optimized volume of groundwater obtained from the proposed model has been studied separately, using

groundwater hydraulic management model, because of the fact that the groundwater cost is sufficiently high as compared to the surface water cost in the Lower Indus Basin and therefore, the groundwater will only be utilized if surface water is exhausted.

The groundwater hydraulic management model consists of groundwater management model which optimizes the pumping rates, and groundwater simulation model which predicts the groundwater response to the optimal quantity of groundwater withdrawals.

The conjunctive use model is applied to the Lower Indus Basin which consists of three barrages and 14 canal commands. The application is performed in three parts. In the first part of the application, the two level optimization model has been used to conduct a detailed study on the Dadu canal command. In the second part, the two level optimization model is applied to the remaining 13 canal commands of the basin to demonstrate the general applicability of the model. Sensitivity analysis is also carried out. In the third part, the groundwater hydraulic management model has been applied to the Dadu canal command to obtain the new groundwater contours.

The results show that a vast scope exists for improving the existing irrigation system of the Lower Indus Basin. The groundwater is under utilized and, therefore, the conjunctive use operation is the dire need of the basin. It is further shown that significant increase in cropping intensities and the benefits can be obtained by implementing the model results. These results can be implemented within the existing infrastructure facilities.

The model is quite general and can be applied to any irrigation management system.

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