Decision-Making Support System for Irrigation Water management of Jingtai Chuan Pumping Irrigation Scheme at the Upper Reaches of Yellow River

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Abstract

Water resources scarcity problem is getting more and more serious to the irrigated agriculture and ecological system in North-west China. Recently 10 years water saving technology has been largely extended in China, especially in North-west China. Improvement of irrigation water management is an important measure to save water and increase water using efficiency. A decision-making support system has been developed to improve water management of Jingtai Chuan Pumping Irrigation Scheme at the upper reaches of Yellow River. The decision-making system is based on the application of computer network and special developed program. Significant economic and social benefits have been achieved by application of the system in Jingtai Chuan Pumping Irrigation Scheme.

INTRODUCTION

The Jingtai Chuan Irrigation Scheme is located in Gansu province of North-west China. It is 187 km in north from Lanzhou, the Capital city of Gansu province. The average annual rainfall in the irrigation district is 201 mm while the average annual evaporation is 2308 mm. The agricultural production heavily depends on irrigation. It was said that there is no agriculture without irrigation in the area. The Jingtai Chuan Irrigation Scheme is a large-scale irrigation project by pumping water from the Yellow River to irrigate grain and other crops. The project was divided into 2 phases, with Phase I complete in 1974 and Phase II complete in 1994.

The total design flow capacity is 28.6 cubic meters per second with an irrigated acreage approaching 54,740 hectares. The design flow capacity of Phase I is 10.6 cubic meters per second with an irrigated area of 20,040 hectares and average lift of 336 meters. The design flow capacity of Phase II is 18 cubic meters per second with an irrigated area of 34,700 hectares and average lift of 460 meters. The scheme encompasses an impressive group of pumping plants, aqueducts, lined canals, tunnels, etc.

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The scheme has significant social and environmental benefits. Up to 1998, the project area had totally produced 2030 million kg grain and 661 million kg oil seed with the total value of 320 million USD. With the project completion, 400,000 people from surrounding mountainous areas have relocated to the project service area. Because of these secondary benefits, the national government pays a high percentage of the electrical costs of pumping the irrigation water.

Due to the complicated and long canal systems, irrigation water management has been very difficult with conventional method. It was noticed that the farmers at the head of canals could have enough water, even surplus water, but the farmers at the tail of canals could not get sufficient water, even no water. Therefore, the water using efficiency is very low. To improve water management and increase water using efficiency, China Institute of Water Resources and Hydropower Research has carried out a project by developing and adopting both canal automation system and decision making support system. This paper is focused on the development of the decision-making support system.
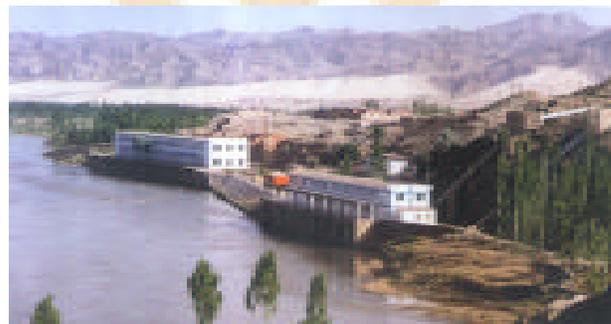

Figure 1. Pumping plants lifting water from Yellow River

Figure 2. Pipe lines of the pumping plant

Figure 3. Aqueduct on canal

Figure 4. Canal through mountains

Figure 5. Harvest season

STRUCTURE OF THE DECISION-MAKING SUPPORT SYSTEM

Irrigation water management related with water sources, climate condition, water requirement, canal feature and water distribution, etc. During the irrigation season these data are changed dynamically. Therefore the decision-making support system for irrigation water management was developed with the dynamic feature by collecting, processing information dynamically. The structure of the decision-making support system is as following:
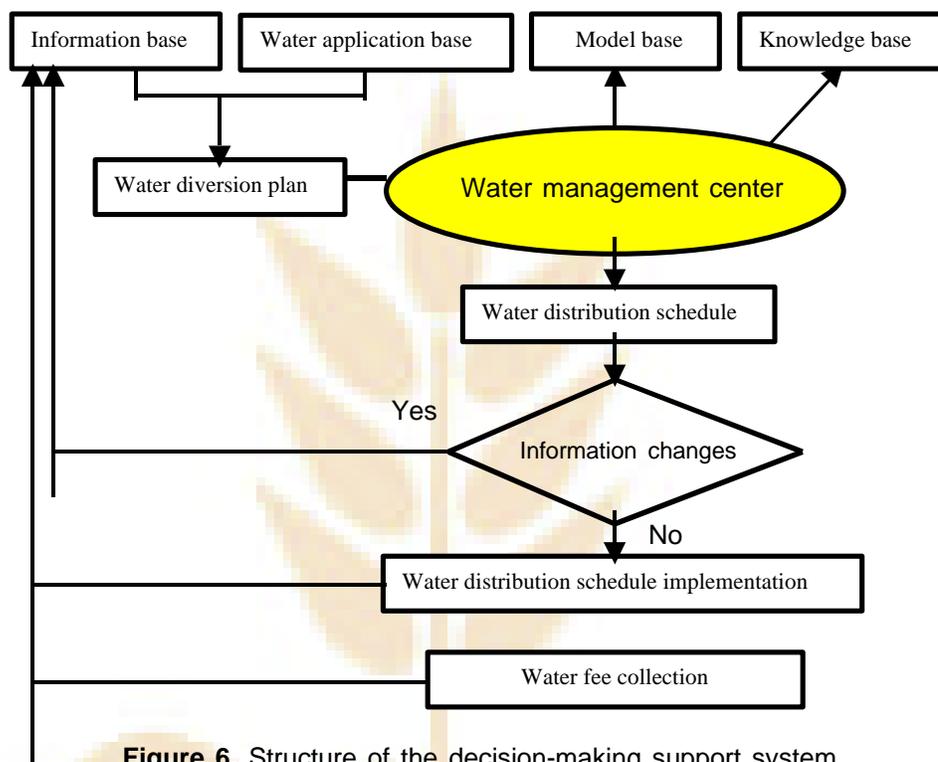

Figure 6. Structure of the decision-making support system

- Information base: including water sources, climate, soil, crops and related agricultural production information.
- Water application: including crop water requirement and water application from water users.
- Model base: including crop water requirement model, irrigation schedule model, canal simulation model, etc.
- Knowledge base: including the experiences related with irrigation water management.

COMPUTER NETWORK

To manage the scheme 10 water management stations were set up in the irrigation district by comprehensive considering administration and canal system condition. The water management stations are in charge of collecting and sending local information to the water management center, and implementing the water distribution schedule worked out by the water management center. The water management center carried out water supply and demand analysis according

to the information from the water management stations. Base on the analysis the water management center worked out the water diverting and distribution plan by recourse the model base and knowledge base. The related offices in the Management Bureau are also linked with the computer network. The computer network is shown as following:
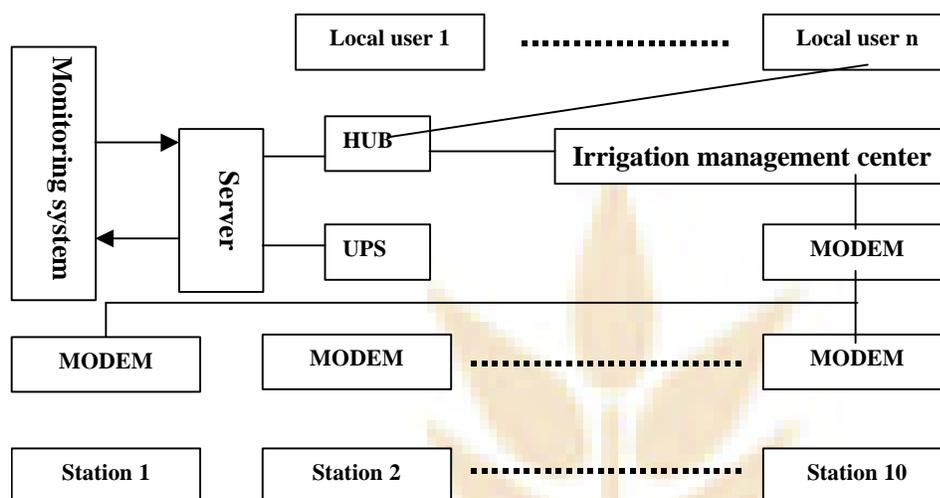
WATER MANAGEMENT PROGRAM

To improvement the water management of the Jingtai Chuan Irrigation Scheme, water management program was developed with the following features:

a. Dynamic water distribution model was developed based on the real water distribution process; the focus was on solving the problem of conflict between water supply and demand.

b. The water management program was developed into package of modules. One module is with one function. The modules were installed together to form the core of the management system.

c. User friend interface was developed to facilitate the extension of the system. Menu system can guide users to use the software easily.

d. The output can be table or figures, or both. It is just a matter of selection.

e. The water management program is easy to be updated.

The main modules are as following :

a. Basic data module

    The basic data module is the base of data and information related to water diversion and distribution, such as canal features of the irrigation district, climate, hydrology, irrigation areas, water users, crops patterns and economic condition, etc.

b. Water application module

Water application module collects and calculates water application volumes from all users. It also calculates the water volumes and rate of discharge of different canals. Water users can apply water according to their need. Water volume can also be calculated with water requirement models.

c. Water planning module

Water planning module is developed to make water diverting and water distribution schedule. According to the water application and water sources condition and canal capacity, water diverting plan and water distribution plan were worked out. If some changes occurred during the irrigation season, such as rainfall without prediction, the module can modified the water diverting and distribution plan timely.

d. Water fee management module

The function of the module is to calculate water volumes and water fee of all users and to record water fee collection statues.

e. Statistic module

The statistic module was designed to record the water distribution process and irrigation progress. It can timely show the irrigated areas and irrigation schedule. This experience is useful information for the future irrigation water management.

f. Communication module

The communication module was used to keep communication between water management center and water management stations, and among users.

g. Print and preview module

The print and preview module was designed to output the model results by tables or figures.

The Decision-making Support System for Irrigation Water management of Jingtai Chuan Pumping Irrigation Scheme has been put into use since 1996. Significant economic and social benefits have been achieved due to the improvement of water management in the irrigation scheme by adopting the system. Both water using efficiency and water distribution uniformity have been increased since the application of the system. The system is with great potential to extend in other irrigation districts in China.