WATER MANAGEMENT IN IRRIGATION COMMAND AREAS

Irrigation is required to obtain high crop yields through optimum scheduling of water application on farms. Both, the quantity and timing of irrigation application, depends on various meteorological factors and soil-water status in the root zone of crops. For maximizing the crop yield, there is a need to carefully plan the regime of watering over the entire crop period. Introduction of canal irrigation facilities in a command area sets new hydrological regime with revised conditions of groundwater recharge and withdrawal. If the water is not utilized as per the developed plan, an imbalance is created in the ecosystem that can lead to further deterioration of the system.

Because of the indiscipline in irrigation water distribution, excess water is used in the head-reach of a command area with a belief that more the water applied to the crop, higher would be the yield. Excess irrigation application causes waterlogging due to rise in subsoil water table. Continued waterlogging results in salinity development and may render the land unproductive. Further, due to irregularities in water distribution, the tail-end of a command area is deprived of irrigation facilities leading to complaints and discontent.

Different methods of water distribution are followed in canal irrigation systems in India. The Warabandi system of Haryana, Punjab and Rajasthan (also known as Osrabandi in Uttar Pradesh) is a system of delivery of water in rotation amongst cultivators sharing water from a canal outlet in proportion to the area of landholding in the canal outlet. The Shejpali and Block systems of Western and Central India are demand-based water distribution systems (operated in the States of Gujarat, Maharashtra, Karnataka and parts of M.P.) in which the estimates of water availability are made and sanctions are provided to the farmers to grow particular crops and draw water to suit their perceived needs. In the Zonal System, introduced in the Lower Bhavani Project in Tamil Nadu, the command area is divided into two halves and each half gets irrigation supplies for wet and dry crops in alternate years. Localized System, in which irrigation proceeds from one field to another through surface flooding, is practiced in most of irrigation projects in Southern and North-eastern States and in the States of West Bengal, Orissa, Bihar and Jammu and Kashmir.

The importance of conjunctive use of surface and groundwater has long been felt in India. Further, the decisionmaking process for irrigation management is handicapped with the non-availability of geographic information on real-time basis and the inability to process and analyze vast quantity of geographic data. With the advent of satellite remote sensing, it has now become possible to gather and update information of large areas at regular intervals. Using a Geographic Information System (GIS), the spatial information can be efficiently stored, analyzed and retrieved.

A number of canal operation simulation models have been developed in the past and discussed in several ICID/FAO publications and Technical Journals. However, there was a need to develop a comprehensive tool (geo-simulation model) that could integrate various processes of irrigation management from micro-scale (field level) to macro-scale (canal system). The tool must be capable of integrating the real-time information coming from remote sensing observations and the spatial details provided by the GIS to help the irrigation managers in analyzing the system operation under current state of the system and analyze various decision alternatives. Recognizing the need of such a tool and importance of conjunctive utilisation of water resources in irrigation commands, a model [Simulation of Integrated Network of Channels for Irrigation (*SINCHAI*)] has been developed.

TECHNOLOGY

SINCHAI integrates the information about the actual irrigation demands in the command area, available canal water at the system head and the groundwater scenario in the area and suggests a possible plan of canal system operation at weekly time step. The model uses the remote sensing data for ascertaining the cropping pattern in the command and is linked to GIS database for utilizing the spatially distributed data of different variables (rainfall, soil type, crop type, canal irrigable areas, groundwater conditions etc). By optimally using the canal water and groundwater, it is possible to keep the groundwater conditions in the command within the desirable range while simultaneously spending least amount of power for groundwater extraction.

SINCHAI consists of two main distributed models [Soil Water Balance Model (SWBM) and Canal Network Simulation Model (CNSM)] and a number of sub-models for database generation and linkage. The purpose of SWBM is to simulate the moisture variation in the root zone of crops for finding spatially distributed irrigation demands, groundwater recharge, crop water stress conditions, and soil moisture content at the end of each week. Figure-1 shows the irrigation demands in a command in a particular week. CNSM is used to analyze various scenarios of canal network

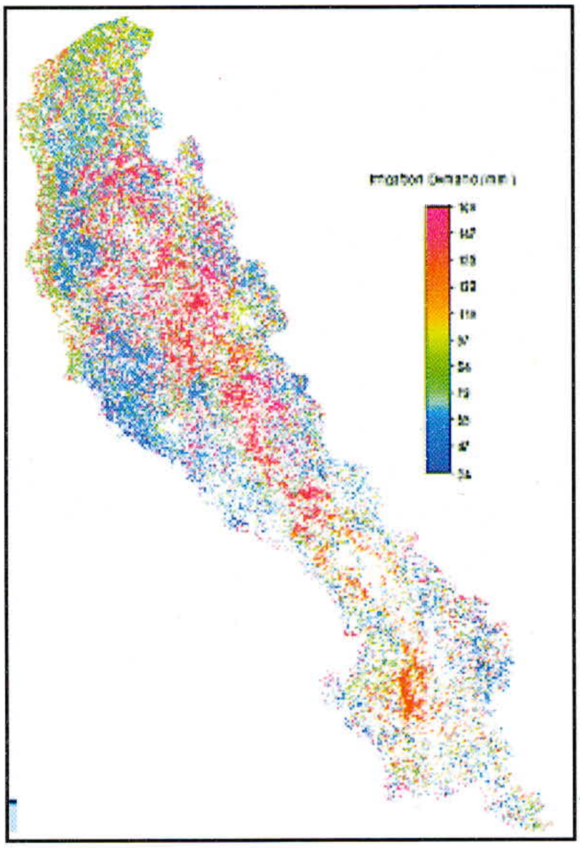

Figure – 1 Irrigation demand map for a particular week

operation on the basis of irrigation demands, canal water supply, groundwater conditions, and characteristics of canal and groundwater distribution system. Provision has been made to simulate five different policies: a)head-reach priority, b) conjunctive use, c) proportionate supply, d) tail-reach priority, and e) conjunctive use with minimum energy demand. For generating revised groundwater conditions corresponding to different operation scenarios, an existing groundwater simulation model (Visual *MODFLOW*) is linked to *SINCHAI*. Figure – 2 shows the canal operation plan corresponding to the irrigation demands, canal water availability, and a specified policy of operation.

To analyze the performance and utilisation of *SINCHAI*, it is applied to Lakhaoti branch canal command (with a gross area of about 1956 sq. km) under the Madhya Ganga Canal System in U.P. State, India. Application of the model is demonstrated for one crop season of a particular year. It is found that under assumed scarcity conditions in one crop season, considerable amount of energy can be saved under similar conditions of water supply to existing crops by judiciously operating the canal system. With *SINCHAI*, various outputs such as irrigation demands, crop stress conditions, groundwater recharge, discharge and run-time of different canal segments, and performance indicators of system can be represented in map form for easy visualization and understanding.

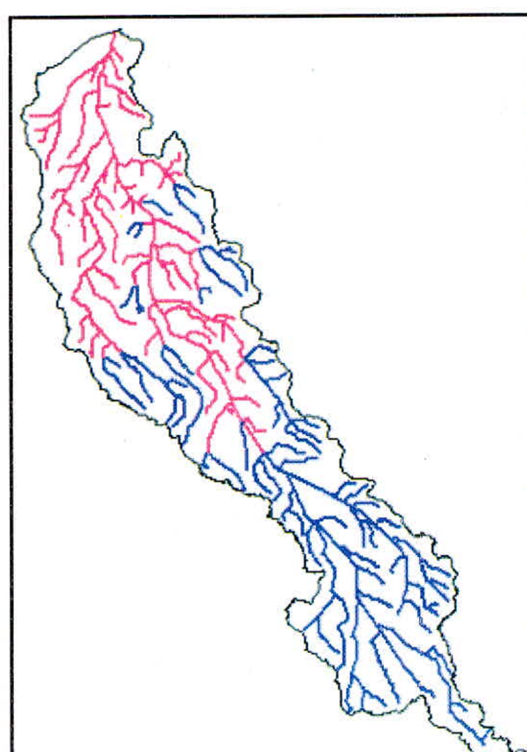

Figure – 2 Canal operation map

ENVIRONMENTAL IMPACT

The model tries to equalize the groundwater conditions in the command area. Withdrawal of groundwater from the waterlogged area helps in reclaiming the submerged lands while recharge of water (as canal seepage) in the deep groundwater areas helps build-up the water table. Therefore, it will have tangible as well as intangible benefits.

ECONOMICS

To apply the developed model in an irrigation command, major expenditure is incurred in the procurement of remote sensing data for cropping pattern determination and canal layout mapping, and digitisation of different data layers in GIS.

BENEFICIARIES

Irrigation Department, Command Area Development Authority, Groundwater Department and the farmers of an irrigation command in general.

INTELLECTUAL PROPERTY RIGHTS

Being the developer of the methodology, the National Institute of Hydrology, Roorkee owns the Intellectual Property Rights of the model.