

INTEGIS

A tool for an integrated analysis of irrigation system management

As part of the collaboration between the International Irrigation Management Institute (IIMI) and Cemagref in Pakistan, research activities have concentrated on the development of an integrated approach to assess the impact of management and policy changes on irrigation system performance. In the context of these activities, an integrated computer tool, *Integis*, is developed to assess the impact of policy and management changes on canal water supply, groundwater use, soil degradation, agriculture production and farm income.

Integis is still in its development phase for one irrigation system, the Chishtian Sub-division. But it has already been partly tested to analyze the link between main canal operation and salinity/sodicity, and to assess the functioning and impact of potential water markets. Its output in terms of cropping intensity has been compared to existing values obtained from satellite imagery and has shown satisfactory results.

Integis facilitates the understanding of the complexity of irrigation systems and of the numerous impacts of given interventions. It complements more detailed disciplinary studies, and provides means to understand the links between these studies. Its spatial output provides a powerful communication means for sharing the output of simulations with other researchers, line agency staff and policy makers.



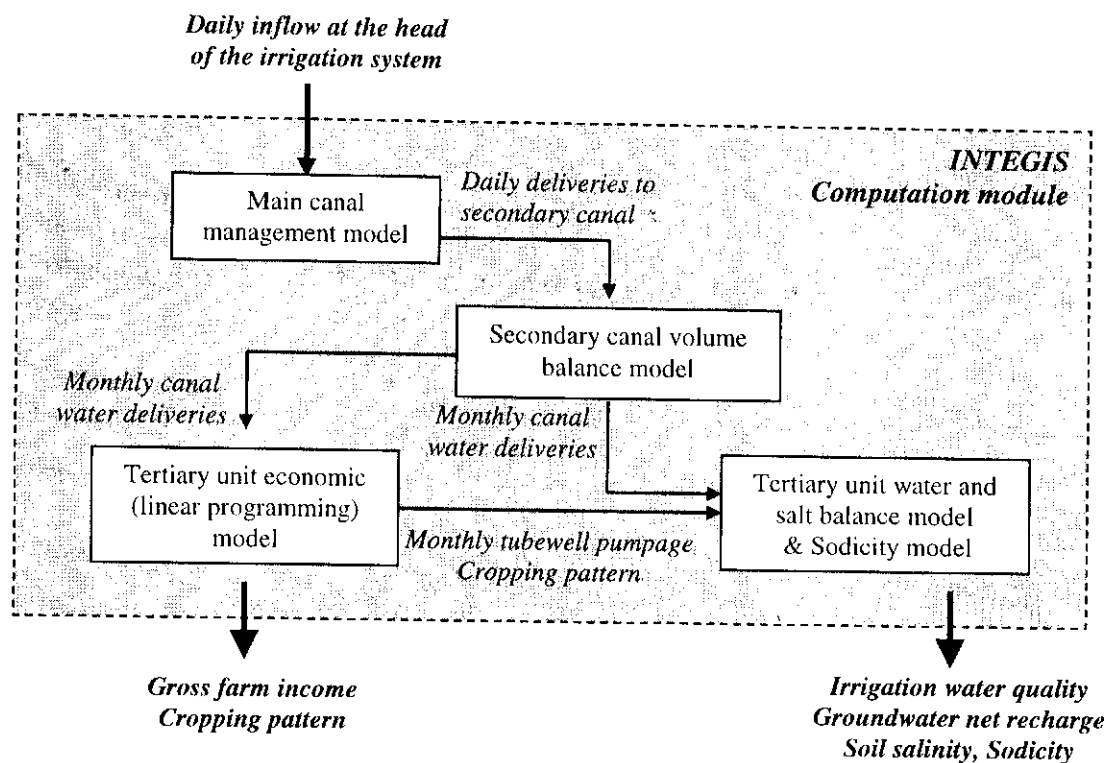
The general *Integis* interface presents some background information on the research collaboration, the integrated approach, and the Chishtian Sub-division, along with the user's guide of the computer tool. It provides access to two operational components of *Integis*:

- The **computation module** built on a MATLAB platform, with a user friendly interface to formalize scenarios and access to the input database.
- The **display module**, mainly based on a customization of the ArcView software to analyse the performance of the scenarios investigated complemented by a summary performance table.

The general interface provides also access to a tool box that contains more complex simulation models that have been developed and applied for more detailed analyses of the bio-physical and decisional processes investigated.

Computation module

The computation module is an interfaced combination of 4 models developed under the MATLAB software. The daily inflow entering the system is distributed to secondary canals through a **water main canal management model**, based on allocation rules and hydraulic constraints. Then, a **volume balance model** shares secondary canals deliveries between tertiary units. The monthly deliveries to these tertiary units are used as input for **economic (linear programming) models** that aggregate farm responses at the watercourse scale. The output of the economic models include the cropping pattern and intensity, farm gross income, and also the monthly tubewell pumpage for farms having different socio-economic characteristics. The cropping pattern and tubewell pumpage information is finally used as input of a **water and salt balance model** and a **sodicity model** (empirical equation). These models compute the average irrigation water quality, soil salinity, sodicity and groundwater net recharge.



Input data requirement

- **Hydraulic/canal management:** main canal allocation rules, main canal hydraulic constraints, tertiary outlets characteristics (dimensions, discharge rating curve), seepage losses.
- **Socio-economic:** characteristics of farm population for tertiary units, water-yield relationships for main crops, input/output prices, water (surface/tubewell) prices.
- **Physical environment:** spatial distribution of soil types, groundwater (tubewell water) quality and water-table depth.

Investigating policy and management

Integis offers the possibility to test and compare a wide range of interventions or scenarios. Those include changes in the main canal operation, remodelling of outlets or lining of watercourses, or policy changes such as changes in tubewell water prices or input/output prices (still under implementation).

Users can select different scales of analysis: the entire Chistian Sub-division, any of the 14 secondary canals, or a selected tertiary unit. The possible scenarios that can be tested vary according to the scale of analysis. For each scenario, changes in selected input data are required. Such changes are directly specified by the user from the *Integis* interface.

Scale of analysis			
Management and policy changes	Chistian Sub-division	Selected secondary canal	Selected tertiary unit
Inflow at the head of the main canal	X		
Main canal allocation rules	X		
Inflow at the head of the secondary canal		X	
Modification of outlet dimensions	X	X	X
Tertiary unit seepage losses	X	X	X
Tubewell water prices	X	X	X

Examples of policy and management changes that can be analyzed with Integis

Rules

File name:

Modify:

Priority order

Daulat	4	1	3	1
Shahar Farid	3	3	1	2
Fordwah	1	2	4	3
Azim	2	4	2	4

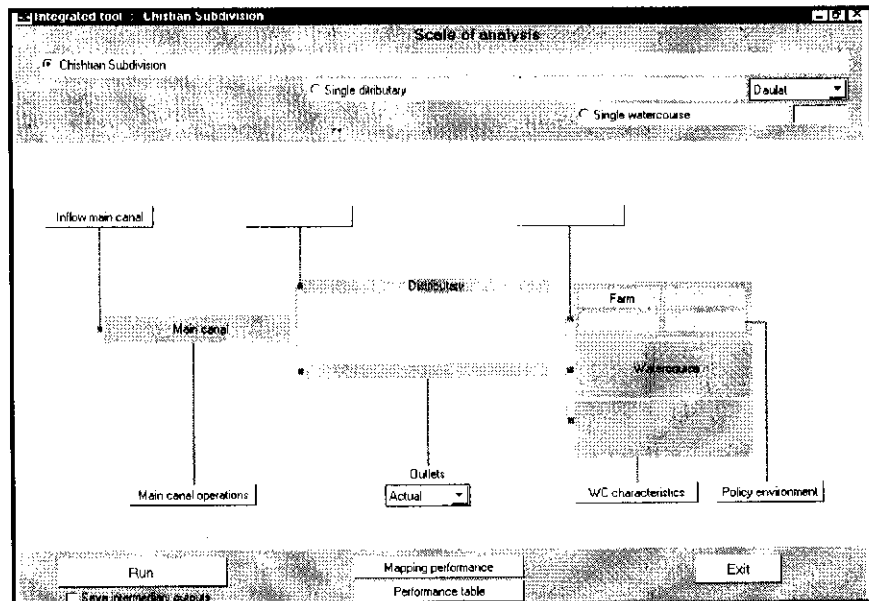
Rotation duration (days)

Target discharges

Daulat	5.5	S. Farid	4.2
Mohar	0.8	Masood	0.8
3L	0.4	Soda	1.9
Phogan	0.7	5L	0.15
Kengahr	1.1	Fordwah	5.3
4L	0.4	Mehmud	0.45
Jagir	0.85	Azim	5.3

Save as:

Main canal management model dialog box: users can specify the rotational schedule (priority order, duration) and the target discharge of each secondary canal.



The interface of the computation module

Display module

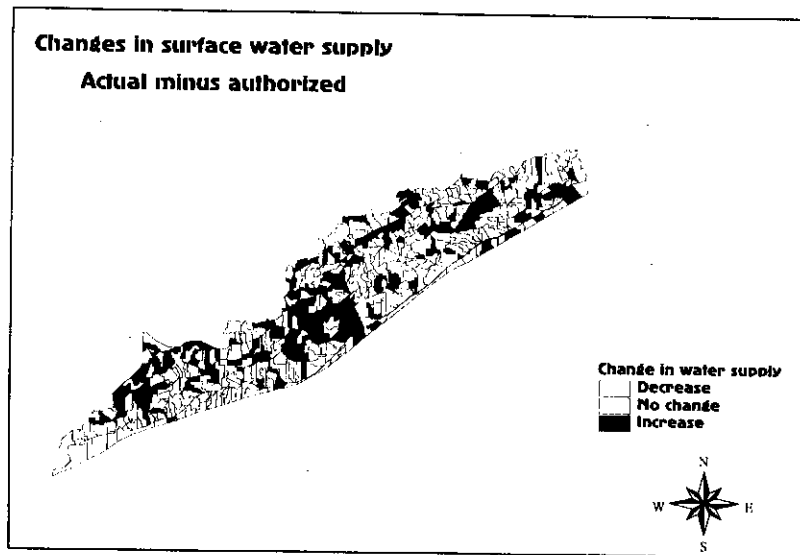
Two options are offered to display the results of simulation of the selected scenarios.

- A summary table provides aggregated performance indicators for the entire Chishtian Sub-division directly from the computation interface.
- Performance indicators can be presented in a map format (under the ArcView software) to investigate their spatial distribution. The spatial analysis provides useful information on areas that have suffered/benefited the most from a given scenarios. This information can then be used to identify alternative scenarios that will be tested with *Integis*, or to specify accompanying targeted interventions that will mitigate the negative impact on suffering areas of the irrigation system.

Performance indicators

- **Water supply**
 - Canal water supply adequacy
 - Tubewell water use
 - Equity in surface water deliveries
- **Agricultural production**
 - Cropping pattern
 - Seasonal cropping intensities
 - Farm gross income
- **Environment**
 - Area affected by salinity
 - Area affected by sodicity
 - Irrigation water quality
 - Groundwater net recharge

Changes in surface water supply
Actual minus authorized



The present map compares the existing and authorized canal water supplies at the scale of the tertiary unit. The information presented is obtained through simulations with *INTEGIS*. It is displayed in a map format using the ArcView software. Such maps are powerful means to present and discuss simulation results with a wide range of stakeholders involved in the management of irrigation systems.

For more information, please contact

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