An integrated approach

Assessing the potential impact of policy and management changes on irrigation system performance

BACKGROUND

While irrigation sector policies and projects have long been based on purely technical interventions, there is a growing recognition for the need to identify appropriate combinations of technical, institutional and economic changes that would improve the productivity and sustainability of the irrigation sector. The identification of appropriate interventions requires a *multi-disciplinary and integrated analysis of the complexity of irrigation systems*, and this for several reasons:

- The stakeholders of the irrigation system (policy makers, managers, and water users) have different objectives such as equity, sustainability, and productivity. These objectives are to be considered jointly in the search for improvements. The tradeoffs between objectives should be emphasized.

- Proposed policy and management changes are likely to influence, directly or indirectly, several inter-linked decisional and biophysical processes. Thus, these processes are to be investigated simultaneously.

- With the increased involvement of water users in the management of the irrigation system, interactions between the different actors and their decisions are reinforced. A simple juxtaposition of disciplinary studies cannot assess the impact of potential improvement on these interrelated decisions and on irrigation system performance.

- The impact of policy and management changes will vary within irrigation systems, as a result of the spatial heterogeneity of the physical and socio-economic environment. This spatial heterogeneity is to be considered for the different processes investigated.

As part of the IIMI-Cemagref collaboration, a study was proposed for developing an *integrated approach to assess the potential impact of policy and management changes on irrigation system performance*. This study has been implemented in the Chishtian Sub-division of the Fordwah Branch Irrigation System, South-Punjab.

The integrated approach developed under this collaboration has been applied to the analysis of two management and policy interventions: (i) modifying main system management to mitigate salinity/sodicity problems; and, (ii) developing surface water market to improve agricultural production and productivity.

INTEGRATED MANAGEMENT, INTEGRATED APPROACH, INTEGRATED MODELS?

- *Integrated management* aims at the implementation of interventions that have been *first negotiated* among actors. Information technologies, conflict resolution and negotiations, institutional and legal arrangements between actors are the main elements of an integrated management framework. The use of an integrated approach may facilitate communication among actors.
- *The integrated approach* aims at the development of a *shared understanding and knowledge* between actors (and among researchers) concerning sub-systems, interactions and processes to take into account in the diagnosis and the evolution of the irrigation system. Sometimes integrated models are developed ffom this shared understanding in order to support policy decisions.
- Individual process-based *models* are linked in an *integrated model* to *simulate* overall consequences of various « what-if » scenarios of interventions on the output of the system.

The integrated approach may be applied at various scales (a field, a farm, an irrigated scheme, and a river basin) with different disciplines (hydrology, hydraulics, economy, agronomy, soil science, and social sciences....) according to the issue considered.

An integrated approach: improving the fit between the analysis of irrigation/drainage systems and policy and management issues?

A restauration of the **equity in canal water supply** is often advocated for the management of the canal network. An integrated approach can provide information on the impact of restoring equity on the aggregated agricultural production of a given canal command area, and on its sustainability in terms of salinity and net recharge to the aquifer.

The combination of economics and hydraulics has stressed that the existing physical infrastructure and canal operational rules would limit the economic **impact of potential transfers of surface water through market mechanisms** between tertiary units and between secondary units.

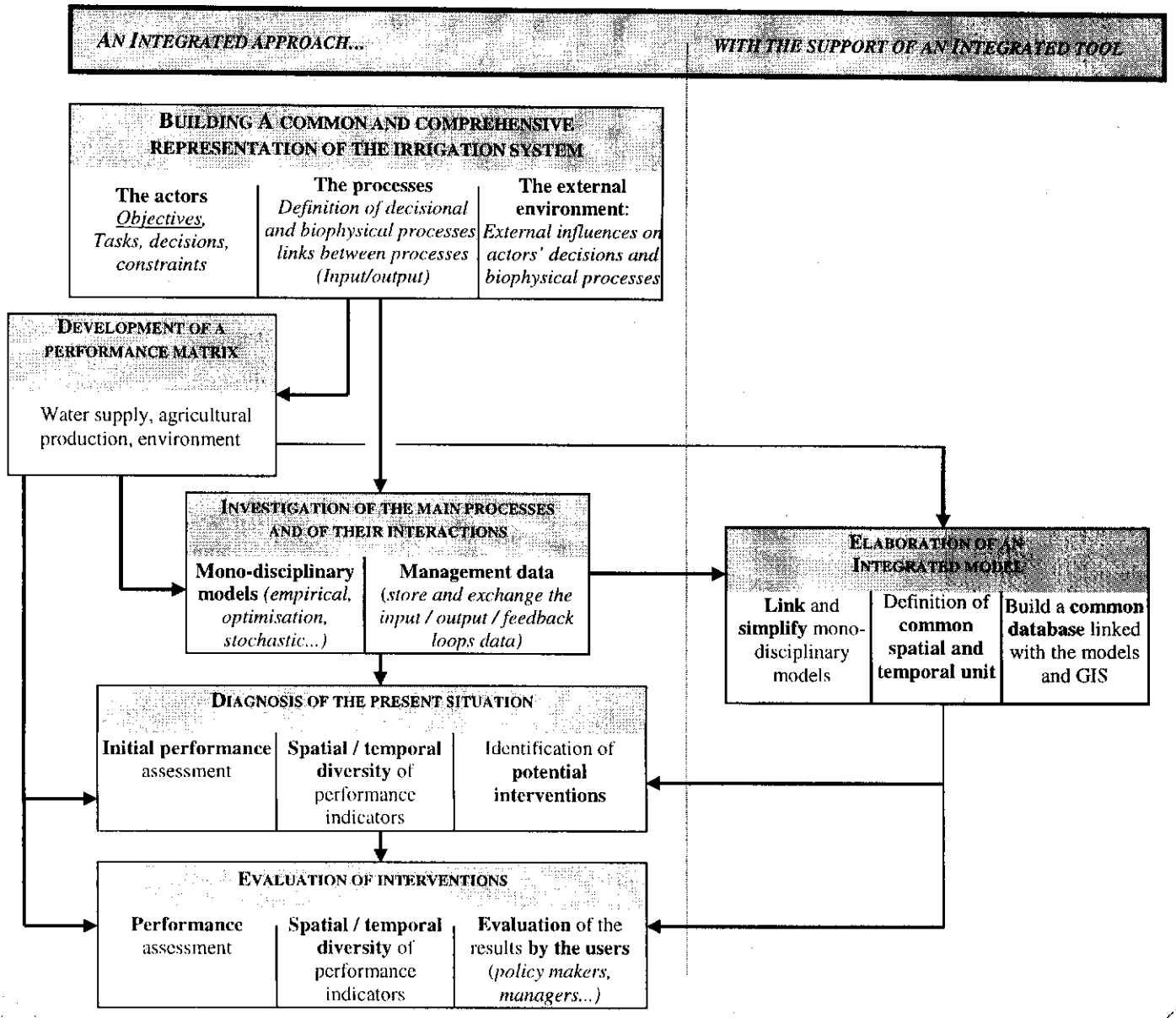
The search for the most **cost-effective combination of irrigation and drainage interventions** to improve the sustainability of irrigated agriculture requires an (optimum) balance between agricultural production and environmental sustainability. This can be done more effectively using an integrated approach.

Because of the pressure on water resources, it is more and more difficult to **allocate extra surface water supplies to tackle salinity and sodicity issues (reclamation shoots)**. Using the integrated approach developed by IIMI and Cemagref, it was shown that the reallocation of surface water from watercourses with ample supplies to watercourses with sodicity risk would significantly mitigate sodicity risk of the latter without reducing the cropping intensity of the former.

An integrated approach to assess the potential impact of policy and management changes on irrigation system performance

The demand for the development of integrated approaches is expected to increase. Looking at larger systems such as river basin, combining sustainability and productivity issues, a higher competition over water resources are driving forces for the development of policies that integrate different uses and actors. Integrated approaches may be applied at various scales (a farm, an irrigated scheme, and a river basin) with different disciplines (hydrology, hydraulics, economics, agronomy, social sciences, etc) to tackle a wide range of interventions and issues. Whatever the issues investigated and the scale of analysis, some methodological issues are common. The development of an integrated approach results in a wide range of methodological issues. This note summarizes some of the experiences obtained by IIMI and Cemagref in Pakistan.

A FRAMEWORK FOR INTEGRATED APPROACHES



METHODOLOGICAL ISSUES AND IMPLEMENTATION CONSTRAINTS

- The development of an integrated approach requires good disciplinary studies. Both the integrated approach and disciplinary studies are complementary, and should be developed in an iterative process. The integration of disciplines, however, is required at the early stages of a research project.

- A good communication between the different researchers involved in the development of integrated approaches is required for its implementation. This can be enhanced through the development of a common platform such as an integrated model or Geographic Information System.

- The implementation of the integrated approach requires interactions between researchers and the different stakeholders of irrigation systems (farmers, policy makers, and irrigation managers). This will help identifying important processes that take place within the irrigation system, define the performance indicators that will be computed, and facilitate the dissemination of the results to these stakeholders.

- Some biophysical and decisional processes are neglected in an integrated approach to keep the level a complexity of the approach manageable. The approach developed, thus, has its limitations in the type of intervention that can be tested and the accuracy of the output obtained from model simulations.

- The computational time required to run simulation models also imposes constraints with regards to the level of complexity that can be considered for the integrated approach.

- As a result of the accuracy issues in model predictions and the complexity of irrigation systems, the validation of the integrated approach is built around two elements: (i) the accuracy of predictions for the actual situation; (ii) the evaluation of the usefulness of the information provided by the integrated approach to take (better) policy decisions. The latter element clearly requires interactions with policy makers and irrigation managers.

- The experience has shown that it is easier to link biophysical models, while it is more difficult to integrate social and institutional aspects. As a result, it is not possible to directly assess the potential impact of institutional changes, unless a clear relationship between these institutional changes and modifications in the processes considered can be established.

- The collection of information to account for the spatial diversity of the processes investigated remains an important issue for large-scale irrigation systems. Often, the required information is not available, accessible, or of adequate quality. This, in turn, will affect the quality of the output obtained through the integrated approach. The availability of information needs to be considered at the early stages of the approach, as it will influence the level of complexity that can be considered.

- As users of the information and integrated approach are often different from those that have collected the information, it is important to document the information process from the source to the database. This will provide a useful means for users to assess the quality of the information and also the quality of the output of the integrated approach.

THE INTEGRATED APPROACH

The main objective of the integrated approach is to test the impact of policy and management interventions on the surface water supply and groundwater use, agricultural production and farm income, and environmental phenomena such as salinity, sodicity and net recharge to the aquifer. These interventions include changes in surface water allocation, remodeling of outlets, maintenance of secondary canals, lining of watercourses, changes in water prices, development of water markets, or changes in prices of agricultural products.

The main elements of the integrated approach

Building a common representation of the irrigation system requires an agreement on the actors considered, the main decisional and biophysical processes that impact on irrigation system performance, and on the influences of the external environment on these processes.

The main decisional and bio-physical processes investigated include surface water allocation and distribution at different scales of the irrigation system, the impact of surface water supply on groundwater use, agricultural production and farm income, and the link between water supply (quality, quantity) and soil salinity/sodicity.

Investigating the spatial diversity of the main variables that influence the selected processes is required to understand the functioning of the irrigation system and link disciplinary studies. The information pertaining to physical and socio-economic variables is obtained from primary and secondary sources for the entire area. The information is stored and structured in a **spatial database** developed under a Geographic Information System (GIS) that also provides a means to display the results of model simulations for different scenarios.

The development and use of simulation models for the different disciplinary studies (hydraulics, economics, soil sciences) provide means to quantify the impact of interventions. The initial analysis of management and policy changes has been undertaken by linking these disciplinary models. Further efforts have concentrated on building an integrated model, *Integis*, that provides a common platform for the disciplinary models and links these models to the databases of the Geographic Information System (GIS).

Validation/evaluation of the integrated approach. The sensitivity analysis of the main parameters and the capability to predict the actual irrigation system performance and its spatial distribution are important elements of the validation/evaluation framework of the integrated approach. Also, the usefulness of the results obtained is assessed by potential users of the integrated approach.

How to use the integrated approach?

- The main purpose of the integrated approach is **not** to identify the optimum policy and management change that would improve irrigation system performance. It provides information that feeds into the policy decision process through an iterative exchange between policy makers and researchers.
- Overall, the use of integrated approaches is expected to facilitate policy decisions and negotiations between the different stakeholders involved in irrigation management.
- Precautions are required with the use of the results obtained from simulations with integrated models. More than providing accurate predictions of impact, the results obtained from simulations will show trends, stress the interrelationships between processes, and provide a better understanding of the irrigation system analyzed.

Communication

- Enhanced communication between researchers is an essential element of an integrated approach. The integration of disciplines means, for each discipline, a good understanding of other disciplines and the integration of elements from other disciplines in disciplinary studies.
- To promote the development of multi-disciplinary research proposals is a first step towards the integration of disciplines. However, systematic efforts are required to effectively integrate disciplines and researchers, and avoid disciplinary results that are only combined at the end of research activities. This can be better achieved with the development of a common representation of the irrigation system and of joint databases.
- Enhanced communication is also required between researchers and policy makers or irrigation managers. More specifically, it is important that researchers investigate performance indicators of interest for policy makers. Also, the interaction with the different stakeholders is required for researchers to identify potential policy and management changes to be analyzed. Finally, the results of the integrated approach, both in terms of the understanding of the existing irrigation system and of the potential impact of management and policy changes, need to be communicated and shared with stakeholders.
- The integrated tool and the maps obtained from the Geographic Information System are important means that will strengthen the communications between researchers, policy makers and irrigation managers.

Information management

- With the development of integrated approaches, information and its management become an increasingly crucial issue. The quality of information clearly conditions the potential of such approaches to provide useful and consistent results.
- The construction of a common database plays a significant role in integrating disciplines and researchers. The development of such a database means identifying variables that will be required for each discipline at different spatial and temporal scales, and also variables that will link disciplines.
- The databases produced in the context of integrated approaches should be made accessible to other researchers and to users. An important step in the development of these databases is to analyse the information requirements of users (policy makers, irrigation managers, etc).
- The management of information requires specific skills that are not always available within research teams. Examples of such skills include database management, information technologies, and Geographic Information Systems (GIS). To strengthen research teams in these skills (new staff, training) is seen as a key to success for developing/applying an integrated approach that will provide suitable information to support policy decisions.