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Management of Irrigation Systems

Guiding Principles

Rural Development Series

Management of Irrigation Systems:

Guiding Principles

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Table of Contents

Note for the reader:
A glossary defining the most important terms used in the text is appended to these guidelines. In order to avoid excessive annotation, glossary terms are marked with an asterisk only where they first appear in one of the main chapters (1 - 5).

Foreword

Even in the earliest history of human civilisations, irrigated agriculture was frequently used to create an economic and power base. The construction, maintenance and use of irrigation infrastructure represent a constant challenge to human ingenuity in terms of engineering skill, the agricultural exploitation of water, and social cooperation.

These three fundamental, interdependent pre-requisites for the development and functioning of irrigation require constant reconsideration of the complex dynamic processes occurring within agricultural production systems. They impose considerable demands on the intellectual and social development of the individual.

These high demands in terms of system-specific and system-adapted cooperative human activity unfortunately meet all too little response in the development and maintenance of capital-intensive irrigation infrastructures. Low economic efficiency, premature decay and high rehabilitation costs are the consequences. In view of the steadily increasing world population, however, capital and labour-intensive land-use based on irrigation is indispensible.

History demonstrates the feasibility of sustained long-term operation of irrigation systems. This implies that greater consideration will need to be given to system-specific, holistic approaches in the future planning, construction and operation of irrigation systems.

In addition to the customary economic and engineering criteria, the potential and abilities of individuals and institutions intended to operate such systems within their existing social and natural environments will be of primary importance for the assessment of irrigation systems. Management aspects will acquire higher priority.

Such aspects also play a part in deciding the scope and nature of cooperation between partners in all phases of implementation, as well as staff qualifications, training needs and the length of time for which external support is required.

The present guiding principles therefore focus mainly on the management of irrigation systems. They are the result of an evaluation of national and international theoretical and practical experience and study of management forms in general and irrigation systems in particular.

The Guiding Principles are addressed both to political and administrative decision-makers and to irrigation specialists.

They aim to provide not patent solutions, but a stimulus for irrigation project management, with concepts aimed at sustainable, economically-viable use of irrigation perimeters.

For practical project work, a supplementary treatment of project experience, procedures and planning and working guides is urgently required. Working aids for operational irrigation system management are therefore in course of preparation, with publication also envisaged for 1989.

Preparation of these guidelines would have been impossible without the effective cooperation and support of colleagues in Section 223 of the Federal Ministry for Economic Cooperation (BMZ) and the Division for Food and Agriculture of the German Foundation for International Development (DSE), the help of experts from the *Kreditanstalt für Wiederaufbau* (KfW) and the active collaboration of scientists and specialists engaged in practical project work.

Our sincere thanks are due to them all for their assistance.

A special debt of gratitude is owed to Dr. W. Huppert and Dr. H. Walker for the inception of the basic concept and for their coordinating and editing work, and to colleagues in Section 123, to Dr. H.-W. Wolter, Dr. R. Kraus von Zabern, Mr. C. Hagen and Mr. A. Vallentin, for their intensive participation in all phases of concept development.

It is our hope that these guidelines may stimulate a productive dialogue on the management of irrigation systems, and so contribute to improving the economic and social situation of water users in the third world.

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1. Introduction

Irrigated agriculture is a significant factor in the economies of a number of developing countries. Confronted by high rates of population growth, with correspondingly increased demand for foodstuffs and agricultural raw materials, the responsible politicians in third world countries have long pinned their hopes on its performance potential, encouraged by experts from the industrialized countries.

Both sides are, however, increasingly conscious that past expectations have rarely been fulfilled, with performance levels for irrigation projects often failing to justify financing, materials and labour.

There are many different reasons for this disappointing performance, at both the **conceptual** and **implementation** levels.

At the **conceptual** level, the prevailing philosophy takes too little account of the systems character of irrigation projects, is over-dominated by a technological and scientific approach, and neglects sociological and institutional aspects of irrigation.

At the **implementation** level, too little attention is paid to water users' interests and indigenous knowledge or to developing and promoting water user* and executing agency* performance potentials* along situation-adapted lines.

These guidelines deal **primarily** with the conceptual level. Implementation will be covered by a subsequent package of working aids including working papers and specific management tools.

The development and practical implementation of situation-adapted project concepts essentially depend on successful 'management'.

> **Management**[1] is the process of designing and controlling goal-oriented* socio-technical* systems in conformity with a given situation. By 'designing', we mean those human activities aimed at creating a socio-technical system and sustaining its long-term via-

1 The definition of management employed here is closely linked with work carried out by the 'Institut für Betriebswirtschaft' of the University of St. Gallen and the St. Gallen Management Centre. Cf. in particular ULRICH (1984) and MALIK (1986).

bility. 'Controlling' denotes the ability to influence the system in such a way that it assumes a desired state.

In the past, there has been undue neglect of management aspects of irrigation systems*, a deficit which these guidelines are intended to remedy.

That is not to say that 'management' is a cure-all for every unanswered question or unsolved problem in the planning, implementation and operation of irrigation systems. As the above definition implies, management's task is to design and control a system. Specialized technical problems of irrigation infrastructure, irrigated agriculture, irrigation economy, etc. require specialized technological solutions provided by the relevant technical discipline, not by management science.

These guidelines consider irrigation systems **solely from the management viewpoint**; technical aspects will be touched on only where relevant to management.

The distinctive - and difficult - feature of management is that it permeates every sector of the irrigation system, since each participant, whether a water user, an agricultural adviser or a water authority engineer, is to some extent involved in designing and controlling the system.

Management science focuses on problems affecting the design and control of socio-technical systems, and tries to find solutions to them. Classic management science long attempted to define **general** principles of organization and management which would be valid irrespective of the situation they were applied to.

A contrasting approach, appealing to many managers interested in specific answers to their own particular problems, is to deduce concrete recommendations from an **individual** case study. Strictly speaking, this makes generalization to other cases impossible.

The **contingency approach*** acknowledges the contingent nature of management principles by trying to predict the effects on management of various contingency factors*, and to deduce appropriate **situation-adapted management recommendations**.

The guidelines adopt a contingency approach of this kind. The numerous possible situations are reduced to four **management-specific situation types** (**Chapter 4**). These are defined in terms of **contingency factors** whose **tendency** to influence system management in certain directions is well-documented by current management science insights and **past irrigation project experience**.

To date, scarcely any empirically-validated cause-effect relationships have been established between the chosen contingency factors and the requirements of irrigation system management. For the present, therefore, only the general trend and scope of a particular influence can be outlined.

In **Chapter 5**, a model management-specific project concept is developed for each of the four situation-types, to act as a form of 'management guide' for those involved in system management.

What is the significance of this procedure for the user of these guidelines? What help can he expect from them in the difficult task of management? The contingency factors defined in **Chapter 4** are intended to enable planners and decision-makers to locate 'their' project in a defined situational context.

Once a project has been assigned to one of the four situation types, the matching **project concept** (**Chapter 5**) ca be selected. This situation-specific project concept is intended as an orientation tool

offering the responsible managers suggestions for **strategic management***, i.e. for overall system design*. **Operational management*** recommendations, i.e. specific **operational** measures for the design and control of individual irrigation system* components, such as water distribution along canals, resource mobilization or the creation of water users' associations, lie outside the scope of these guidelines.

The guidelines are therefore addressed primarily to those concerned with **identifying**, **designing** and **controlling** irrigation projects or actively involved in **strategic** management as project managers or management consultants.

Important as the strategic management level may be for the design and control of a system, it relies on appropriate **operational** management to ensure that the developing system remains oriented towards the chosen

objectives. These guidelines will therefore shortly be supplemented by a **set of working aids** for operational irrigation system management.

To keep the guidelines as short as possible, the basic principles of the concept will be described here in highly condensed form only. The guidelines are based on conceptual work carried out at the GTZ since 1984, and summarized in a basic paper on the Management of Irrigation Systems to be published separately in 1989.

Summary of Chapter 1 (Definitions of terms marked with an asterisk appear in the glossary)

- Irrigation projects in developing countries often fail to meet expectations.
- One important deficit is in the area of management*, at both the conceptual and implementation levels.
- Management is the process of designing and controlling goal-oriented* socio-technical* systems* in conformity with specific situations.
- The guidelines approach the problems of irrigation systems* from a purely management angle. Technical and economic aspects of irrigation are dealt with only marginally, and only insofar as they are relevant to management problems.
- The guidelines are based on a system-oriented, contingency* approach.
- The guidelines define management-specific situation types as a basis for the creation of corresponding project concepts*.
- The guidelines provide recommendations for overall **strategic management***. No advice is given at the **operational management*** level.
- The guidelines are aimed at the group of persons mainly engaged in the strategic management of irrigation systems.
- The guidelines will be supplemented by a set of working aids for operational irrigation system management

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2. Point of Departure for the Development of a Basic Concept for Irrigation System Management

2.1 Previous Approaches to the Promotion of Irrigation Systems in Developing Countries

Past experience is important for our understanding of irrigation systems*. The following section briefly reviews some significant forms of intervention by domestic and foreign interest groups in the irrigation sector of developing countries. The point of departure in each case will be a consideration of national **promotion policy*** and its interaction with external institutions, whether local administrations in the colonial era or development cooperation* donor organizations in the post-colonial phase.

a) In the **colonial period**, a number of powers supported the construction of irrigation systems by their local colonial administrations. These were aimed mainly at providing cheap supplies of raw materials for the rapidly expanding industry of the colonial power. This objective could most readily be achieved by constructing large-scale irrigation schemes organized along semi-industrial lines, with responsibility solely in the hands of foreign management employing western technology.

b) The transition from the colonial to the post-colonial era **(1960's and early 1970's)** brought only gradual change. Development policies in this period aimed at reproducing the principles of western agriculture in the developing countries. There were growing demands for the production of subsistence crops, to supplement the cash crops largely grown hitherto. Local personnel became increasingly involved in management, and foreign specialists tended more and more to assume advisory status. In addition, development cooperation stressed the importance of independent small-scale water users* as a potential target group.

   Associated with these developments were certain shifts in the demands made on management. In particular, increased emphasis on the importance of water users and their role as independent farmers modified management attitudes towards this group.

c) From the middle of the **nineteen-seventies** onwards - especially following Robert Mc Namara's speech in Nairobi - a fundamental rethinking of western development policy was noticeable. This was not without implications for the discussion of development approaches in the irrigation sector. Allowing for the specific characteristics of irrigation, the main emphases of promotion policy during this period were as follows:

- The essential feature of aid policy is its concentration on the interests and needs of the poorer classes of the population. In irrigation system terms, this means that small farmers are the primary target group, and crop choice takes into account their risk minimization and food security needs.

- The technology used should be adapted to the performance potential* of local management and water users, and not transferred indiscriminately from industrial countries. Traditional water-user know-how about irrigation engineering and processes should be integrated in the management concept.

- There is a demand for greater participation by the target group*, in this case the water users, in the planning and implementation of measures.This implies that the local authority and the donor organizations should involve themselves much more intensively with the water users and their situation.

- Project measures should be designed to trigger self-sustaining processes which make irrigation schemes as independent as possible of long-term external aid.

2.2 Unsatisfactory Philosophies and Procedures at the Irrigation System Management Level

Certain central shortcomings bar the way to situation- and goal-oriented management. These can be identified in the practical planning, implementation and operation of irrigation projects.

a) An isolated, **monodisciplinary** approach to irrigation still prevails. Even in the project planning phase, too little account is taken of **system and sub-system interrelationships**. This neglect continues at the operational stage.

b) Both planning results and practical project implementation are characterized by a primarily **technical** approach to complex irrigation systems. This effect is complicated by the primarily irrigation engineering background of the managers concerned.

c) Too little attention is paid to the close relationship between the management of the systems and their **system environment***. In the past, decision-makers in irrigation projects have thought too little about ways of harmonizing the system with the constraints and demands of the system environment.

d) **Traditional local irrigation practices and know-how** receive too little attention in the planning, construction and operation of new systems and the rehabilitation of existing ones. Water users' performance potential is not fully utilized and their indigenous knowledge and skills remain largely unexploited.

e) The tools of project planning, monitoring and control hitherto used in development cooperation are **insufficiently flexible** to satisfy the complex demands imposed on irrigation system management.

2.3 Unsatisfactory Results of Past Irrigation Projects

International donor organizations, local institutions and interest groups and, not least, the water users themselves are frequently dissatisfied with the results achieved by irrigation projects. Dissatisfaction may be located at the following levels:

a) The Economic Level:

Economic goals are often achieved neither at the farm nor at the national level. At farm level, inefficient use of water and capacity restrictions (especially on labour) combine with uncertain water supplies to prevent anticipated yields - and therefore desired income - from materializing.

At macroeconomic level, yields seldom justify the high development and maintenance costs involved. *Ex post facto*, the profitability of a project is often less than originally envisaged.

The recurrent costs of irrigation projects for the developing countries are substantial, and tend to be underestimated. The foreign currency component of recurrent costs is often extremely high.

b) **The Social and Institutional Level:**

Inequitable distribution of water between users is a worldwide phenomenon; especially where head-end canal users receive preferential treatment at the expense of tail-end users, it often leads to poorer income distribution and social tensions.

In many cases, relatively rigid institutional rules imposed by the water agency have destroyed functioning organic social structures. Too little effort is often made to promote and exploit water-user participation*.

One result of these failings is a lack of identification with the project by the water users. The anticipated mobilization of resources by the water users then often fails to materialize.

c) **The Ecological Level:**

A number of irrigation systems function only at restricted capacity, due to the environmental damage caused by the systems themselves (e.g. salinization); extensive rehabilitation is needed to restore systems to full operation.

2.4. Objectives of a Conceptual Reorientation of Irrigation System Management

Previous experience of third world irrigation projects indicates that new avenues will have to be explored if the shortcomings described in **Chapter 2.2** are to be eliminated and better results achieved. One possible approach lies in improved system management. It should be stressed that

> improved management cannot automatically solve all the problems affecting irrigation systems. The overriding and at the same time integrating character of management does, however, lend it special importance in socio-technical systems.

Improved management demands a concept which makes it easier for persons and groups involved in an irrigation system to contribute effectively to its goal- and situation-oriented design and control.

These guidelines aim to develop a basic concept of this kind. The point of departure for this concept is

> a **systems-oriented contingency approach** which sees irrigation projects as **goal-oriented, open socio-technical systems**, in which **people** are looked on as decision-makers and implementers within a specific **system environment**.

Modern organization and management science pursue an approach of this kind. The advantage of such an approach is that it sees the construction of a functional organization* and the performance of management functions* within it as a process fundamentally shaped by **people** interacting with social and technical factors. It is therefore particularly suited to the socio-technical character of irrigation systems.

The fact that socio-technical systems of this type are designed and controlled by people does not imply that those responsible for practical system management enjoy a completely free hand. In fact, in the real world of system management, all participants operate within a network of differing and dynamic **situational constraints**, which influence management. Those responsible for irrigation system management - and this includes both the manager of a water authority and the water user - are invariably constrained by a given situation. The improved concept which is being sought here must, therefore, provide guidance for a **situation-adapted** management of irrigation systems.

Many irrigation systems in developing countries are not currently run exclusively by national agencies*, but with the aid of staff, equipment and financing from external donor organizations. In **management cooperation*** of this kind, two conflicting management and development philosophies may emerge. To be practicable, an improved concept should aim to enable management to combine the external development contribution with local resources, while allowing for the different interests involved and the constraints imposed by the situation.

Finally, the proposed concept should try to indicate ways of improving and intensifying cooperation between the local authority, donor organization representatives and the water users.

Summary Chapter 2 (terms marked with an asterisk are defined in the glossary).

- Since the mid-seventies, development policy on irrigation project aid has tended to pay greater attention to the needs of the potential beneficiaries.
- Even today, irrigation project management* is essentially characterized by the following concepts and procedures: a monodisciplinary approach, neglect of system interrelationships and sub-system interlinkage*, an emphasis on (irrigation) technology, inadequate consideration of the system environment* and a lack of flexibility in the management tools employed for project planning, monitoring and control.
- The results of irrigation projects are often unsatisfactory both in economic terms (at farm and at national level) and in social, institutional and ecological respects.
- One area in which new approaches are possible is system* management. The concept which will be put forward here is intended as a guide to the process of designing and controlling irrigation systems*. It is based on a systems-oriented, contingency approach* perceiving irrigation projects as goal-oriented*, open*, socio-technical* systems centred on people as decision-makers and implementers acting within a specific system environment.

3. Attributes of a Basic Concept for the Management of Irrigation Systems

3.1 Preliminary Remarks

Only if the complexity of irrigation systems* is understood can they be planned and operated with optimum efficiency in conformity with the situational context in which they exist. Certain explanatory concepts are essential to such an understanding. These concepts must be formulated in terms general enough to allow comparative description and analysis of the structure and functioning of different types of irrigation system - a requirement basically met by systems theory*. Modern management and organization theory likewise provides the specific theoretical approaches needed for an understanding of irrigation management and organization problems.

The terms organization* and management* frequently lead to confusion, since each of these words is used in both an institutional and a functional context. Each also describes phenomena at different system levels, so that - depending on the approach adopted - either of the two may be regarded as a sub-term of the other:

- in the **institutional** sense, management constitutes a sub-system of an organization and is defined as that group of individuals in the organization with authorization and responsibility for carrying out **management functions**. Management functions, in turn, are discharged to varying degrees by various **representatives of the organization**. In this context, the organization is regarded as a goal-oriented social structure with a definable group of members. This structure acts as the framework within which management as an institution exercises its management functions.

- in the **functional** sense, the process of 'organizing' is a sub-function of management (cf. **Chapter 3.3.2**).

3.2 Concept-Related Features of Irrigation System Management

3.2.1 System-Oriented Features of Irrigation

The point of departure for deducing explanatory concepts for irrigation system management is the **systems approach**. In very general terms, a **system*** may be understood as the sum of **elements** linked to one another by interrelationships. Wherever the interrelational intensity within a group of elements is clearly greater than between the group and other elements of the system, we refer to that group as a **sub-system**.

Using the systems approach, irrigation systems may generally be defined as

> systems in which people endeavour to use **water** in an **organized** way at a specific location so that the irrigation-specific products and services produced will help to fulfil the goals of water users and other interested groups.

Irrigation systems defined in this way exhibit the following **characteristics**:

- they are classified as socio-technical systems,
- they are open to their system environments,
- they are goal-oriented.

3.2.1.1 The Socio-Technical Character of Irrigation Systems

Socio-technical* systems comprise social and technical elements and sub-systems. Within the system, special importance is attached to the **interaction** of social and technical system attributes. In irrigation systems, this is particularly significant, since the 'technical' infrastructure of dams, canals and distribution devices frequently overshadows the 'social' infrastructure, such as the water users' institutions. A successful management must take into account the socio-technical nature of the system.

3.2.1.2 Openness* to the System Environment

Irrigation systems may in reality be characterized as more or less **open systems**, since the processes of acquiring and converting inputs and producing outputs take place in close, continuous exchange with the **system environment***.

There are interactive relationships between the system and its system environment, expressed in the influence of the system environment on the system and vice versa. The expression 'system environment' used here should be distinguished from the narrower term **environment***, whose connotations are here restricted to ecological/biological factors such as climatic, soil and hydrological conditions.

For management purposes, it is helpful to distinguish further between the general and the specific system environment. The **general** system environment includes everything external to the system which may influence or potentially be influenced by it. The **specific** system environment comprises only

> those components of the general system environment which directly affect the attainment of the system's goals or are directly influenced by the system's impacts.

Since the specific system environment is of primary importance for the attainment of the system objectives, the management of an irrigation system must endeavour to embrace it by means of specific management strategies and to acquire the greatest possible control over it.

Generally speaking, the system environment of an irrigation system may be sub-divided into the following sectors:

- **the ecological system environment**: comprising natural phenomena, such as climate, soil conditions and water availability,
- **the technological system environment**: comprising all technical resources potentially available to system management together with the pertinent technological know-how,
- **the economic environment**: comprising the economic and socio-political conditions in markets for inputs and outputs, such as production factors, prices (including water prices), interest rates, terms of delivery, import and export regulations,
- **the administrative environment**: comprising the structure and workings of local bodies, for example the performance potential* and political orientation of ministries, water authorities and groups of water users,

- **the legal system environment**: comprising the entire legal framework within which the system exists, especially agricultural legislation including land and water laws, the administrative legal framework, labour laws, etc.,

- **the socio-cultural environment**: comprising existing social structures, institutions, value systems, behaviour patterns, status and role distribution, together with the knowledge, skills and individual readiness to contribute of the water users.

Management decides in each case whether part of the system environment constitutes a **specific** environmental factor for an irrigation system. The **market price for cotton** is, for example, a **specific** environmental factor for a state-run cotton project, whereas for a neighbouring small-farm irrigation perimeter, where only food crops are grown, it forms part of the **general** system environment. This status changes if the small farmers decide to produce cotton for a state marketing organization.

In connection with the system environment, two further factors play an important role for irrigation management: the complexity and the dynamics of environmental influences. The **complexity*** of the system environment is expressed primarily in the number of influencing factors and their range of differentiation. Its **dynamics*** result from the frequency of changes in its influences, and from their unpredictability and consequent irregularity. The more dynamic and complex the system environment, the greater the **management uncertainty** associated with decisions and actions (cf. **Chapter 4**).

3.2.1.3 Goal-Orientation* of Irrigation Systems

Like all socio-technical systems, irrigation systems are essentially intended to create products or services* (cf. **Chapter 3.3.1**). The precise products and services generated are decided by the **goals** and **interests** of the persons and groups able to influence management of the irrigation system in some way. This set of persons is, in the practical situation of third-world irrigation systems, generally extremely large and correspondingly heterogeneous. It is rarely confined to representatives of a responsible agency or a water users' organization. Decisions within irrigation systems are therefore to be understood as the result of **bargaining processes**. The goals of individuals or groups may easily conflict.

In line with the goal-orientation of irrigation systems, management must develop optimum strategies for the design and control of the system.

Since the objectives of irrigation systems differ, no standardized set of goals can be formulated for all irrigation projects. Theoretically, management will always be confronted with a set of **specific interest groups** and thus with a specific set of goals.

Development practice shows, however, that a number of **general goals** do exist, and are continually re-expressed in connection with irrigation projects, primarily by the governments and institutions of the donor and recipient countries. These goals are located chiefly at the **economic level**, and reflect the maxim that socio-technical systems must be 'economically viable' if they are to survive over the long term.

At the economic level, some frequently stated goals are:

- to increase agricultural production through efficient utilization of the water supplied by the system,
- to increase incomes, especially of small irrigated farm units, and
- to ensure that the project is profitable at the macroeconomic level.

Apart from these goals, objectives such as improved income distribution, job creation and an improved infrastructure are often cited. The common feature of all such goal descriptions is that, individually, they provide no **clear definition** of the nature of goal-oriented design and control of the irrigation systems concerned. Thus, for example, the goal of increasing production and income can be attained either by creating and strengthening independent water users' organizations, or by assisting a responsible water authority, or by a combination of these two strategies. A decision as to the most feasible and promising strategy for goal achievement can be made only for the case in hand, and by taking the **situation** into account, i.e. primarily by estimating the available performance potentials of all participants.

3.2.2 Situation-Oriented Attributes of Irrigation System Management

The management of existing socio-technical systems always takes place within a particular concrete **situation***.

> This situation may be defined as the sum of the specific factor sets in the **system environment** and of the specific **system-internal** factor sets in the particular case.

The **contingency approach*** to management theory endeavours to take account of this by assuming that

> different situations must be responded to by **different management concepts**.

In this process, an attempt is made to identify the relevant contingency factors and estimate their specific impacts on system management. The results can then be used as a guide to the development of a management concept for the specific situation. This procedure is adopted in these guidelines (cf. **Chapters 4 and 5**).

3.2.3 Process-Oriented Attributes of Irrigation System Management

Modern management concepts understand system management as a **process***, i.e. as a flexible sequence of steps and procedures, each of which can be employed in accordance with the **current development status** of the system and which permit a process of learning from previous steps by means of feedback mechanisms. The process-oriented perspective, like the contingency approach, has not been applied systematically to the development of irrigation system management concepts.

In most cases, it is assumed that a management concept, once selected, can be employed without modification throughout the different phases of a project. Recent management insights indicate that this assumption is incorrect.

3.3 Implementation-Oriented Attributes of Irrigation System Management

3.3.1 Performance Attributes of Irrigation Systems

To date, management theory and management science have been oriented largely towards income-producing, **profit-making** production units. Irrigated agriculture in developing countries hardly fits such a model. A significant number of irrigation projects should be defined rather as **non-profit organizations***, characterized as follows:

- Non-profit organizations pursue **need-satisfaction** objectives. Goals associated with the provision of services **to satisfy needs** acquire greater importance as compared to the **formal goals** of earning profits or achieving high rates of return on capital investment.

- Outputs of this kind are frequently of a **qualitative** or **intangible** nature and therefore present problems in terms of **operationalization** and **performance evaluation**.

- An important performance area in non-profit organizations is the **service sector**. In practice, it is evident that services to water users play an important role in most irrigation systems. This highlights the question of how to frame **relationships between irrigation agencies and their water user clients**.

- Non-profit organizations have a greater responsibility than their profit-oriented equivalents towards **interest groups*** in their political and administrative environments which wish to influence decisions. Management is therefore dependent on external groups to a relatively high degree; its powers may be considerably curtailed and multiple, relatively vague goals must be reckoned with.

One consequence of this is that the management of a non-profit irrigation organization will need to adopt more differentiated procedures in deference to the heterogeneous nature of the services it provides.

All the above-mentioned aspects of non-profit organizations will be referred to as required when situation-specific management concepts are developed for various irrigation projects in the course of these guidelines (cf. **Chapter 5**).

3.3.2 Management Functions in Irrigation Systems

Individuals entrusted with management responsibilities in socio-technical systems must perform certain **management functions***. A large body of modern management literature assumes that the entire field of management functions can be reduced to the four basic functions of planning, organizing, leading and controlling[1]. A discussion of management functions appears in **Chapter 5**, as part of the definition of situation-specific project concepts. Management functions are discussed solely

1 The management function of 'planning' should not be confused with the 'planning' phase, which constitutes the first step in the sequence of phases for project planning and implementation (Chapter 5).

at the strategic management level, not in terms of operational management.

In this context, the management functions may be defined as follows:

- **Planning**[1]: systematic analysis of goals, deduction of alternative, goal-oriented measures, and preparation and justification of a decision in collaboration with those participating in or affected by it.

- **Organizing**: designing organizational structure and interrelationships between organization members, taking into account the external interest groups, the available resources and the varying system environment factors.

- **Leading**: goal-oriented personal influencing of the attitudes and behaviour of members of the organization and the interaction between them. Conflict management and communication also fall within this sphere.

- **Controlling**: continuous monitoring to ensure that measures implemented coincide with planning intentions, determining deviations, initiating corrective measures, measuring impacts and adapting planning.

A return to general basic functions of management may be unexpected in the irrigation context, since a more obvious course in the context of the irrigation system discussion might be to search for **irrigation-specific** management functions. Frequently cited are water acquisition and distribution 'functions', operational and infrastructure-maintenance 'functions' or resource-mobilization 'functions'.

In line with the systems character of the concept presented in these guidelines, reference to such specific irrigation management functions has been avoided. The purpose is to avoid any impression that individual sub-systems of an irrigation system can be successfully designed and controlled independently of other elements of the system. This would not pay due regard to the interdependent nature of the system.

Irrigation systems are characterized by extremely complex and heterogeneous sub-systems on both the **input** (supply) and **output** (service)

1 Vide supra, p. 17 (footnote).

sides. All components of these sub-systems need to be planned, organized, led and controlled. Too strict a water orientation inevitably leads to the kind of **short-sighted** view generally referred to as 'irrigation management' or 'water management', which has been responsible for a number of the shortcomings in the planning and operation of irrigation systems described in **Chapter 2**.

Another question which arises is the role to be played by the '**decision-making**' function. Decision-making is here assigned to a **higher** hierarchical level. Each of the four basic functions demands continuous **decision-making processes** on the part of management. The decision-making function thus **permeates** the management functions, or, put in another way, managers are decision-makers who exercise the four management functions of planning, organizing, leading and controlling.

In line with the contingency concept adopted in these guidelines, it is assumed that the exercise of these basic management functions is subject to the influence of the actual situation, and therefore that different ways of using the management functions have to be adopted in different situational configurations (cf. **Chapter 5**).

3.3.3 Potential Performers of Management Functions in Irrigation Systems

A considerable problem is posed for irrigation system management in developing countries by the normally heterogeneous set of persons and groups who may be regarded as or claim entitlement to be potential performers of management functions. These are:

a) Representatives of local water authorities,
b) Representatives of the water users and
c) Representatives of donor organizations.

ad a)
The most prevalent group of potential performers of management functions, encountered in almost all irrigation systems, are representatives of national **irrigation organizations** officially responsible for the supply and/or distribution of water for irrigation purposes in a particular country. These may be either governmental or non-governmental organizations.

ad b)
Water users in third world irrigation systems are mainly independent farmers, who are basically free to determine the use and exploitation of

their means of production. Their freedom of action is, however, curtailed where a water source has to be used jointly. Joint use of water requires coordination with other users and with the responsible water authorities.

In all cases where farmers operate their irrigation systems, management functions are exercised by the farmers themselves. Where an irrigation organization is also involved in system management, management functions will be discharged by both parties (**divided management responsibility***). The extent to which particular management responsibilities devolve on the authority or the water users in each specific instance will depend on the situation, and especially on the **performance potential** of the two parties.

ad c)
Wherever irrigation systems are not constructed and operated solely by farmers and/or national water authorities, a third force, currently of great importance for the management of irrigation systems in developing countries, becomes involved. This third force, consisting of the external **donor organizations***, is able to exert a powerful influence on irrigation system management through its provision of material, financial and human resources.

3.3.4 Attributes of Project Management in Irrigation Systems

In management terminology, it is generally agreed that a **project*** may be defined as

> a package of measures characterized by its uniqueness and by time, space and budget limitations with regard to a defined goal.

In industrial management science, it is normally assumed that the resources of staff and materials required to implement project measures will be supplied by a '**parent organization**' or in certain instances by several different parent organizations. As indicated by the above definition, these resources are diverted to the newly-created project organization[1] for a limited period of time. Theoretically, the project will be completed and the project organization can be disbanded once all problems have been solved and the specified goal has been attained.

1 It should be pointed out that a project will not necessarily have its own organization and staff. For irrigation projects, however, this will normally be the case.

For situations of the kind defined above, 'project management' concepts differing in a variety of ways from the routine management of the parent organizations have been developed. The most important difference may well be the **time factor**; the limited duration of the project means that the organizational structure needed to implement project measures will differ from the structure required for the the long-term operations of the parent organization.

The complex, innovative and often labour-intensive task of creating a new irrigation system or rehabilitating an existing one generally overtaxes the resources of the normal operation of the parent organizations.The creation and rehabilitation of irrigation systems is therefore usually regarded as an independent task, at least partially separate from the parent organization, and thus treated as a 'project'.

This locally identified and, in certain situations, locally initiated 'irrigation project' may now become the object of **external support** in the form of staff, funding and equipment/materials. An external project responsive particularly to the management principles of the donor organization is therefore superimposed on the local project. It is nonetheless common practice to speak of a project run by the partner, the implementation of which is facilitated or made possible by an external contribution.

One obvious approach might be to apply project management methods used in the industrial sector to the management of irrigation projects. It should, however, be noted that in irrigation projects, depending on the situation concerned, lower priority may be accorded to agricultural production than to **developing and building up the irrigation organization** itself. The goal of **institutional development*** will not infrequently take priority over pure production or productivity objectives, especially in the initial phase of the irrigation project.

3.3.5 Water-User Related Attributes of Irrigation System Management

The extent to which farmers, as the final consumers of water, should and can **participate*** in the planning, implementation and operation of an irrigation system applies only in relation to a given situation. The size of the system is of decisive importance, as are the types of problem to be solved, the interests involved and the performance potential of the groups concerned. The fact that the level of participation is contingent on the situation means that the frequently-voiced demand for maximum water-

user participation is not particularly apposite; the objective should rather be optimum participation.

It remains fundamentally true that planners and managers have tended to pay too little attention to the water users in irrigation systems. As many traditional irrigation systems prove, however, water users may be perfectly capable of constructing and operating successful systems of their own. Such systems are generally on a smaller scale, utilize relatively simple technology and are closely adapted to the situation.

Whereas the operation of traditional irrigation systems has, in the past, been largely independent of state-run or private water authorities, such agencies generally play an important role in international development cooperation in the irrigation sector. This raises the question of the division of tasks and responsibilities between the water authority and the water users (cf. Chapter 5.3).

A broad spectrum of alternatives is conceivable, depending on the situation. At one end, irrigation projects may be designed in such a way that in the long term all irrigation-related tasks can be carried out autonomously by the water users. State or private institutions then confine themselves to providing services such as agricultural extension or provision of inputs. Any solution of this kind presupposes that water users possess a high performance potential, in terms not only of their technological know-how, but of their ability to organize themselves efficiently.

At the other end of the spectrum, the situation may demand a solution in which all significant areas of responsibility are covered by the water authority and the water users are assigned only minor implementational tasks, for example in the tertiary irrigation system.

In practice, however, the 'middle' of the spectrum is likely to be of the greatest importance. This is the area where tasks and responsibilities are divided between the water users and the responsible water authority. Experience of jointly-operated systems shows that in certain situations water users can manage at least the field canal system successfully, as far as operation and maintenance, water distribution and conflict-solving are concerned. Autonomous functioning at this level provides the best foundation for increased water-user participation in overall system management decisions.

The emphasis on water user orientation in irrigation projects means that there must be intensive investigation of the real situation of water users, so that their interests and resources can be evaluated and successful measures can be planned and implemented to increase their performance potential and thus optimize their project participation.

3.3.6 Sustainability-Oriented Attributes of Irrigation System Management

3.3.6.1 Fundamental Considerations

One important conclusion which can be drawn from the management concept developed here and its foundations in system theory is that the management of irrigation systems must be designed to ensure **system conservation***. This means that the principle of **sustainability*** must be taken into account in performing management functions and pursuing management strategies.

It has often been incorrectly assumed, particularly in the irrigation sector, that once an adequate **physical** performance potential has been created and satisfactory **profitability** demonstrated (according to European criteria), the sustainability of the system will be assured. If the question of sustainability is to be addressed seriously, however, more attention needs to be paid to creating **institutional performance potentials** for the responsible authorities and water users as part of development cooperation.

Also of critical importance in assuring the sustainability of a project's impacts is the need to consider the system environment as it will be **after** completion of the external aid contribution. Attention must be paid at the earliest possible stage to devising sustainability strategies aimed at mobilizing support from all influential interest groups in the irrigation system. Support will be easier to attain if the relevant decision-makers in the developing country share or are prepared to take serious note of the basic concepts presented in these guidelines. With a view to sustaining a project's impacts, support should therefore be concentrated on those irrigation projects where a wide degree of consensus with the interest groups on the irrigation system management concept can be achieved.

3.3.6.2 Ensuring Environmental Compatibility

As explained in Chapter 3.2.1, the natural environment may be regarded as a sub-system of the system environment of an irrigation system. This emphasizes the importance of environmental damage caused by irrigation systems, and distinguishes it more sharply from the general relationships between the irrigation system and its system environment.

At the level of formal goals, most of those responsible for the construction and operation of irrigation systems agree that systems should remain operational over the long term. At the level of real goals, however, it is evident that both national governments and farmers as water users work with a marked time preference. In most cases they pursue short-term goals at the expense of long-term conservation of the environment. This short-term perspective conflicts with the need to counteract potential environmental damage at the earliest possible stage in the planning and decision-making process.

Reliable predictions of the adverse impacts of irrigation are relatively hard to make. Depending on the situation and the performance potentials involved, certain environmental sectors require special attention. Conceivable measures for ensuring environmental compatibility* in these sectors are:

- measures integrating environmental compatibility more strongly in hydrological master plans,
- specific measures to increase the performance potential of the responsible irrigation agency and the water-users, with a view to strengthening water control/monitoring functions,
- measures aimed at modifying environment-related behaviour patterns of water users,
- measures for improving the maintenance of irrigation infrastructure,
- measures for the construction or extension and maintenance of drainage installations,
- measures aimed at preventing or alleviating water-borne diseases,
- measures for rehabilitating or conserving water catchment areas.

From the point of view of development cooperation, consideration of the environmental compatibility of irrigation systems entails inclusion of the environmental compatibility aspects of all envisaged measures in the planning process. On no account should these be lost sight of when designing control functions, for example when setting up an M + E system.

Summary Chapter 3 (terms marked with an asterisk are defined in the glossary).

- Distinction between the terms organization* and management* in their institutional and functional senses,
- Definition of the term irrigation system* based on the systems approach,
- Irrigation systems* are characterized as :

  socio-technical*: emphasis on the coordination of social and technical system attributes,

  open*: **reciprocal** relationships exist between irrigation systems and their system environments. A distinction is drawn between the **general system environment*** and the **specific system environment***. The latter is of particular importance for management. Environmental segments: ecological environment (natural environment), technological, economic, administrative, legal and socio-cultural environments,

  goal-oriented*: orientation towards goals determined by internal and external **interest groups*** expecting goods and services from the system. Goals are situation-specific.
- Management is understood as a **process*** allowing continuous learning* from previous steps via feedback mechanisms,
- Irrigation systems* are often **non-profit organizations***. Commercial (profit-related) goals have a lower priority than **need-related** goals. The services performed are often of a **qualitative, intangible** nature, and thus difficult to measure or control.
- **Services*** constitute an important output of irrigation systems*.
- The management* of irrigation systems* performs four **management functions***: planning, organizing, leading and controlling. Superimposed on these is the **decision-making function**. The management

functions are formulated in general terms, since the narrower, irrigation-specific definition customary in 'water management' is incompatible with a systems view.

- The agencies responsible for performing management functions in irrigation systems are primarily local water authorities, water users* and donor organizations*.
- The construction and rehabilitation of irrigation systems is carried out in the form of projects* within the framework of development cooperation*. The point of departure is the partner country's project, supported by contributions from a donor organization*. In the initial phase of an irrigation project, the goal of **institutional development*** can be of foremost importance.
- Insufficient account is still taken of water-user **participation***. Since the degree of participation* is **situation-dependent**, the aim should be **optimum** rather than maximum water user participation.
- The management of irrigation systems must pay continuous regard to sustainability* and environmental compatibility* and take appropriate measures to safeguard them as far as possible.

4. Points of Departure for Situation-Oriented Management of Irrigation Systems

4.1 Preliminary Remarks

All persons or groups performing management functions* in irrigation systems must deal with the **concrete situation*** in which the irrigation system exists. Different situations make different demands on management. Many different situation sets are encountered in third-world irrigation practice. From the management point of view, it would be ideal if specific management actions could be recommended for each situation. In real terms, this is not possible. On the basis of existing experience concerning the relationships between situation and management, this chapter therefore attempts to:

1. reduce the wide variety of possible situation sets to a **spectrum** of situational configurations relevant to **management requirements** (**Chapter 4.2**);

2. identify the range of situations within this spectrum which offer relatively favourable conditions for successful irrigation management in terms of their **management-specific demands** on available **management tools** and **development goals** (**Chapter 4.3**).

Chapter 5 then endeavours to develop a **management-specific project concept** fitting each of the identified situation types and providing those responsible with advice on the **strategic management*** of 'their' irrigation system.

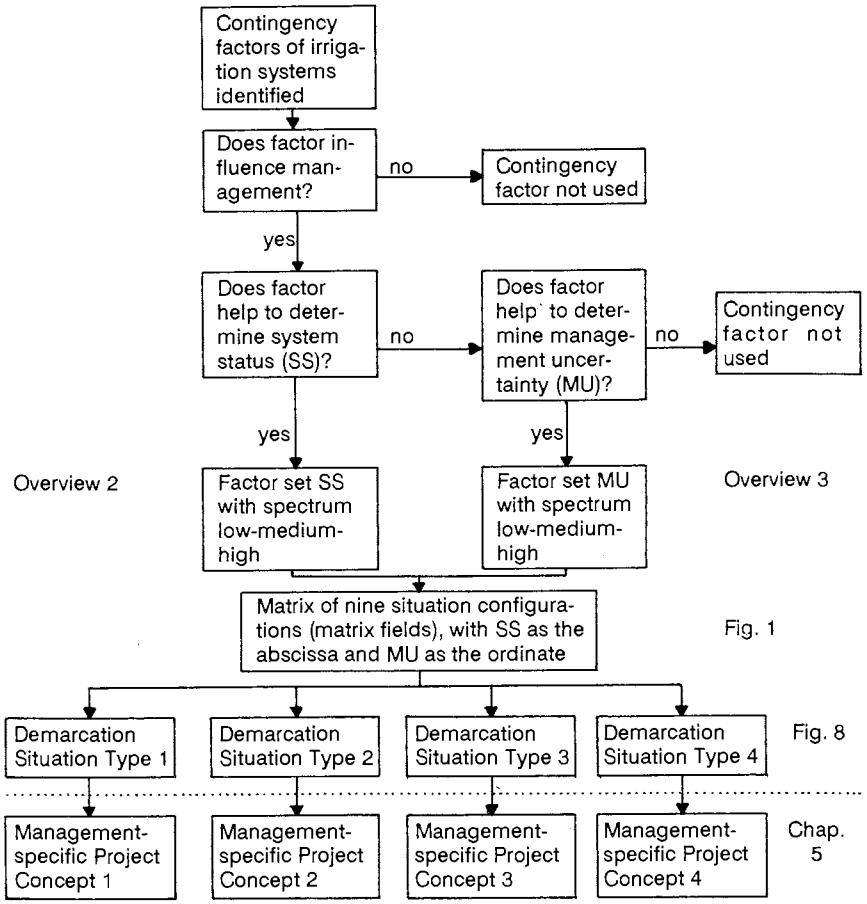
Overview 1 is a flow chart outlining the **structure of Chapter 4** and acting as an interface with **Chapter 5**.

4.2 Reducing the Variety of Management-Related Situation Sets

4.2.1 Fundamental Considerations

Since these guiding principles are concerned with questions of irrigation system management, attempts to reduce situational variety must be judged by the extent to which their results support **successful manage-**

Overview 1: **Flow Chart Showing the Structure of Chapter 4**
(cf. **Overview 4** for procedure used to define situation types)



ment of such systems. The range of possible situational sets has here been narrowed down to those situations that are of particular relevance for successful management.[1]

4.2.2 Derivation of Management-Specific Contingency Factors

4.2.2.1 Selection Criteria

In order to understand, describe and evaluate a situation, suitable **contingency factors** must be defined. In a real irrigation system, there is a multiplicity of influencing factors. One criterion for the selection of contingency factors is their special **relevance to the design and control of socio-technical systems** in the past. Literature dealing both with irrigation-system management and with the management of socio-technical systems outside the irrigation sector refers to contingency factors of this kind. A common feature of these contingency factors is that existing experience and knowledge adequately indicate the influence they will **tend** to have on the management of the system.

The selected contingency factors are grouped into two **factor sets** denoted '**irrigation system status**' and '**management uncertainty**' respectively. As far as possible in view of the sometimes limited empirical data, contingency factors with a **tendency to influence management in the same direction** are combined in a single set. With the aid of the two factor sets, the **spectrum of management-specific situation configurations** can then be defined as a matrix (**Chapter 4.2.3**).

4.2.2.2 Irrigation System Status

The factor set 'system status'* is defined as the totality of all contingency factors except for system environment and performance potential, both of which correspond to management uncertainty*. System status substantially influences the distribution of management responsibility between water authority and water users. The spectrum extends from low to high system status. Important determinants of system status are amongst the factors indicated in **Overview 2**.

1 Since attempts to narrow the spectrum of socio-technical systems differ according to the purpose served, different procedures and results may be expected to emerge when purely irrigation-engineering or purely economic criteria are applied.

Overview 2: Status of the Irrigation System (System Status)

Low	System Status	High
• Small total irrigated/irrigable area		• Large total irrigated/irrigable area
• Small number of water users		• Large number of water users
• Small number of operational levels*		• Large number of operational levels*
• Production goals of water users emphasize need and safety aspects		• Production goals of strongly oriented towards national/ international markets
• High flexibility and divisibility of technology		• Low flexibility and divisibility of technology

It is important to understand that a transition from low to high status involves more than a modification of primarily 'technical' factors, such as the total area or number of users. In many cases, such a transition also implies modification of the goal system of the interest groups concerned, of the demands made on management capacity and resources, and of the nature and intensity of dependence on the system environment. An attempt to operate a large-scale, technically-demanding irrigation project largely under the autonomous control of its water users, in pursuit of subsistence goals, will encounter limitations, just as will an attempt to pursue exclusively cash-crop oriented goals in a small-scale system collectively operated by traditional water users.

4.2.2.3 Management Uncertainty

Apart from the contingency factors considered in the factor set 'system status', there are many contingency factors which primarily affect the certainty or uncertainty of management decisions in irrigation systems. These factors may be grouped in a factor set designated '**management uncertainty**'.

Overview 3 lists factors which previous experience indicates are responsible for management uncertainty in irrigation systems.

The analysis of management uncertainty in irrigation systems must be closely related to the actual system status in each case. In irrigation systems with a 'low' system status, the level of management uncertainty from the point of view of the **water users*** will be of interest, whereas in systems with 'high' status, management uncertainty from the point of view

Overview 3: Management Uncertainty

Low	Management Uncertainty	High
• Long irrigation tradition* of water users and/or water authority		• Short irrigation tradition of water users and/or water authority
• Low complexity* of system environment*		• High complexity of system environment
• Low dynamics* of system environment		• High dynamics of system environment
Low dependence* on system environment		• High dependence on system environment
• Reliable resource availability		• Unreliable resource availability
• Low goal conflict potential		• High goal conflict potential
• High goal quality*		• Low goal quality
• Small discrepancy between task requirements and performance potential of water users and/or water authority		• Large discrepancy between task requirements and performance potential of water users and/or water authority

of the responsible **water authority*** will be of primary importance. In systems with split responsibility, management uncertainty from both the water-user and water-authority viewpoints requires analysis and attention.

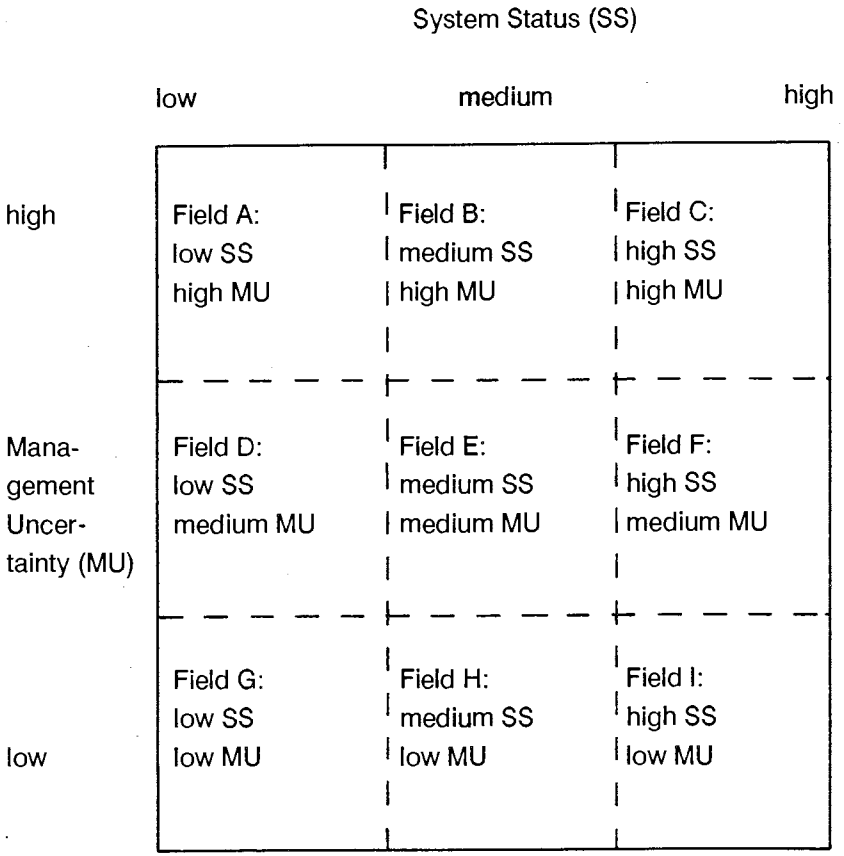
4.2.3 The Spectrum of Management-Specific Situation Configurations

In the preceding sections, an attempt has been made to select from the wide range of contingency factors those particularly relevant to the **management** of irrigation systems. In the previous section, these contingency factors were grouped into two factor sets.

On the basis of these two factor sets, the two-dimensional matrix in **Figure 1** presents the **spectrum of irrigation system situations** in terms of management requirements. The matrix fields represent the **situational configurations** which may confront the management of an irrigation system in the process of designing and controlling the system.

Adopting the contingency approach*, an attempt might now be made to develop a specific **management concept*** for each field. This is, however, neither necessary nor useful, since it can be shown that **cer-**

Fig. 1: Spectrum of Irrigation System Situations in Terms of Management Requirements



tain sectors of the matrix are in practice either unsuited for project implementation or scarcely acceptable in development policy terms. These sectors need to be identified and excluded on the basis of suitable criteria. The chosen criteria and the consequences entailed by the exclusion of certain sectors in terms of the definition of management-related project concepts are discussed in **Chapters 4.2.3.1** to **4.2.3.4**.

4.2.3.1 Management-Specific Demands on Development Cooperation

The top section of the matrix (Fields A - C) is an extremely **critical** zone in terms of the goal of achieving a potentially successful form of irrigation management. High management uncertainty, expressed primarily in the inadequacy of water user and water authority performance potentials* calls for comprehensive and highly **personnel-intensive intervention in the institutional field**. At present, such interventions are possible only on a limited scale within the development cooperation framework. This is due to the developing countries' reluctance to acknowledge the need for institutional development. Deficits also remain in donor organization's contributions to third world management consultancy and institutional development. The top section of the matrix may, therefore, be regarded as a zone of **high risk for development cooperation**.

Closely related to the management-specific demands on development cooperation in irrigation systems is the question of which **group of individuals** is responsible for management of the overall system in a particular case. For irrigation systems, it may be stated that

> depending on the situation, management responsibility is exercised by **different groups**.

Figure 2 shows the way in which the composition of the group entrusted with system management alters with system status. Whereas with low system status ('small' systems), management responsibility devolves largely or even wholly on the **water users**, the influence of (para-) governmental or private water authorities tends to increase with higher system status. In extreme cases, a responsible water authority may take over all management functions completely.

Since from the management's point of view there are many distinctions between water users and water authorities, development cooperation practice must invariably allow for the way responsibilities are distributed in a particular situation.

4.2.3.2 Requirements of Recipient Countries for External Support in the Irrigation Management Sector

In development cooperation practice, the spectrum of situation configurations in **Figure 1** is further narrowed by the anticipated **requirement**

Fig. 2: Distribution of Areas of Management Responsibility between Water Users and Water Authority

System Status

low	medium	high
Management responsibility largely with **water users**, i.e. in extreme cases managed exclusively by water users.	Divided responsibility; **water users** and **water authority** each take over individual areas of responsibility.	Management responsibility largely with **water authority** i.e. in extreme cases operated exclusively by authority.

for external support in the irrigation management sector by developing countries. This requirement is not the same in each of the nine fields.

Figure 3 depicts the management-related **demand structure**. It indicates that a high or very high demand for management-related support is to be expected in the range of medium to high management uncertainty (Fields A - F). In this range, the primary need is for **personnel-intensive management consultancy**. This chiefly involves **setting up the agency, organizational development*** and **training** for the responsible agency or water users. Depending on the situation, this management consultancy may need to be supplemented by effective **financial (investment) support**.

Owing to the well-developed performance potentials available, the developing countries' need for management consultancy in the zone of **low management uncertainty** (Fields G - I) may be regarded as relatively small. In development cooperation practice, there is, however,

Fig. 3: Requirement for External Support in the Irrigation Management Sector within the Development Cooperation Framework

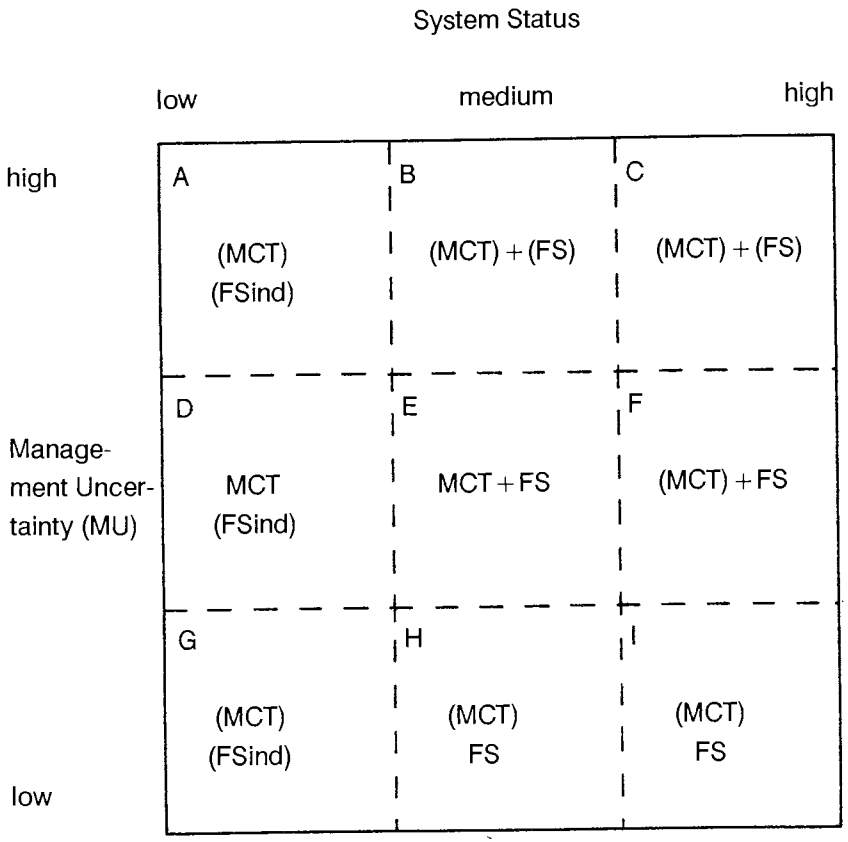
System Status

Management Uncertainty (MU)	low	medium	high
high	A + + +	B + + + +	C + +
	D + +	E + + +	F + + +
low	G (+)	H +	I +

potential in this area for purely **financial support** (financial cooperation), supplemented by selective problem-specific management consultancy.

The matrix in **Figure 4** shows which situation configurations separately or jointly favour the **successful** use of management consultancy and financial (investment) support, from the irrigation system **management point of view**.

Fig. 4: Situation-Related Weighting of Management Consultancy Services and External Financial Support in Irrigation Systems



MCT:	Focus on management consultancy (incl. training)
FS:	Focus on external financial (investment) support
(MCT):	Limited need for management consultancy
(FS):	Limited need for external financial support
FSind:	Only indirect financial support via local institutions or in conjunction with MCT is useful
+:	Close cooperation MCT-FS essential

In this context, the two above-mentioned areas of support - management consultancy and external financial support - have deliberately not been equated with existing institutions for technical and financial cooperation. Although (personnel-intensive) management consultancy services play a primary role in the field of technical cooperation, investments are also made in almost all technical cooperation projects. Similarly, in the financial cooperation field, financial support may be supplemented effectively by management consultancy.

In view of the management problems concerned, it would appear useful to think in terms, not of the institutional categories of technical and financial cooperation, but initially of service-related categories. The implications for performance requirements should then serve as a basis for the institutions to devise their own service-related forms of organization.[1]

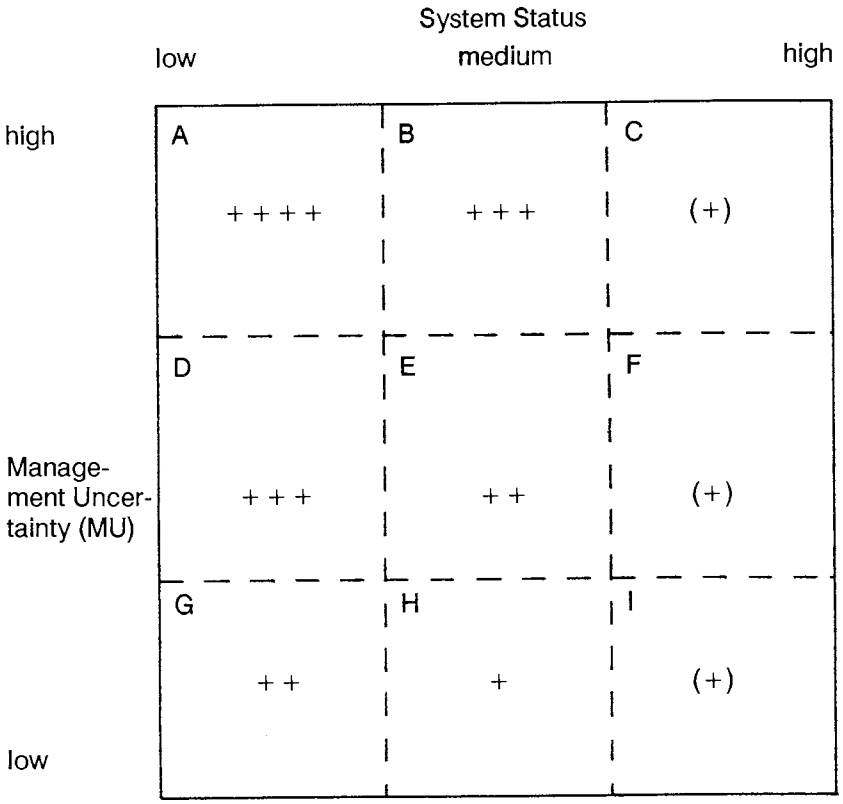
The **limitations on the use of the services** indicated in brackets in **Figure 4** are entailed by the following considerations:

- Under **high management uncertainty** (Fields A - C) poor local performance potential means a high demand for management consultancy (**Figure 3**), but at the same time the **risk factor** attached to successful consultancy in the development project context is particularly high. In addition, the necessary **management tools** for qualified management consultancy, especially in the area of agency promotion and organizational development, are not yet sufficiently developed.

- Under **low system status** (left-hand column of the matrix), pure financial support for investments is of limited applicability; in this zone, management responsibility is exercised principally by the water users (cf. **Figure 2**), who generally fail to fulfil the criteria specified by financial aid agencies for a project executing agency. State or private **irrigation authorities** exercise little or no influence on the management of these systems. In such cases, investments may usefully be implemented **indirectly** via other institutions (e.g. cooperative credit organizations) or in close conjunction with management consultancy.

1 In line with their remit, the present guidelines are oriented primarily towards the goals and constraints of technical cooperation. It may be anticipated that, at least in some areas, the considerations presented here entail somewhat different consequences for the organization of financial cooperation.

Fig. 5: Development Policy Priorities for Irrigation Systems in the Context of Development Cooperation



- Under **low management uncertainty**, the use of consultancy services is limited primarily by the low requirement of the recipient countries for such services, as indicated in **Figure 3**.

4.2.3.3 Development Policy Objectives of the Donor Country

The requirement of the recipient country for external support finds its counterpart in certain development policy accents and goals of the donor country. A glance at the matrix will show that, from a **development policy viewpoint**, the development cooperation priority of the individual situation configuration decreases both from top to bottom and from left to right of the matrix (**Figure 5**):

- In the area of high management uncertainty, inadequate performance potentials are the main problem, calling for personnel-intensive external support in the form of **institutional and organizational development**. From a sustainability point of view, support in this area must be accorded the highest priority.

- The **basic-need and target-group orientation** and the **principle of participation*** on which development policy is based require attention to be concentrated mainly on small water users and their high-priority goals. Systems in the area of low system status provide good conditions for this. Large-scale projects administered by water authorities (high system status, right-hand column of the matrix) can meet such requirements only with difficulty and within certain limitations.

4.2.3.4 Summary of the Criteria for Defining Situation Types

The criteria discussed in the two preceding sections are intended to narrow the full spectrum of situational configurations in the matrix to the range relevant to the design and control of irrigation systems in developing countries **within the development cooperation framework**. Care must be taken not to see criteria in isolation, since their impacts may partially overlap.

Figure 6 summarizes the most important criteria and their situation-specific, management-related impacts in terms of the matrix.

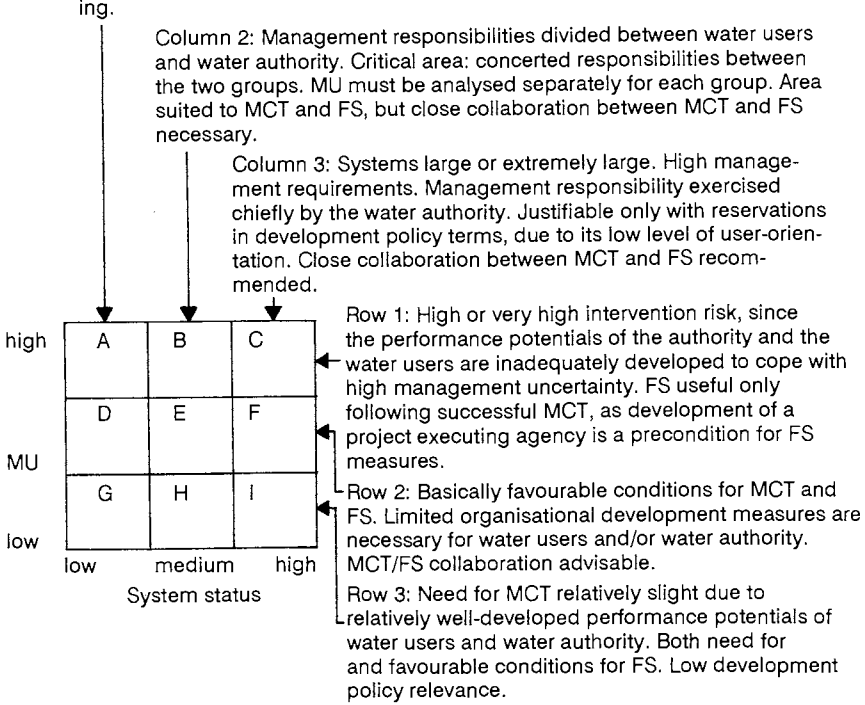
4.3 Definition of the Management-Oriented Intervention Zone for Development Cooperation

The conclusion to be drawn from the discussion of criteria is that

> on management criteria, not all situation areas of the matrix are suitable for potentially successful development cooperation; some marginal areas are left blank.

Fundamentally, the following areas of the matrix are marginal in the above sense :

Fig. 6: Summary of the Most Important Criteria for the Definition of Situation Types in Relation to Irrigation System Management



MU = management uncertainty (cf. Overview 3)
MCT = management consultancy incl. training (cf. Fig. 4)
FS = financial (investment) support (cf. Fig. 4)

– **High management uncertainty**: the risk of intervention in this area is particularly high. This is partly due to high management capacity requirements. Moreover, both donors and recipient institutions dispose of limited know-how in this field of intervention (top edge of the matrix).

– **High system status**: limitations here derive both from the **high management requirements** for development cooperation and from **development policy aspects** (inadequate consideration of basic needs, target group and participation criteria; right-hand edge of the matrix),

– **Low management uncertainty**: restrictions here are the **recipient countries' need for consultancy services in the management sector**, which decreases with decreasing management uncertainty, and the conflict between the recipient countries' desire for **purely financial aid** in this area and the donor countries' **relatively low development policy preference** (bottom edge of the matrix).

These limitations enable us to define an area of the matrix in which development cooperation appears especially promising **on management criteria** and highly relevant in development policy terms (**intervention zone**). In **Figure 7**, this area is indicated by a broken perimeter, which may be regarded as the **intervention line*** for development cooperation.

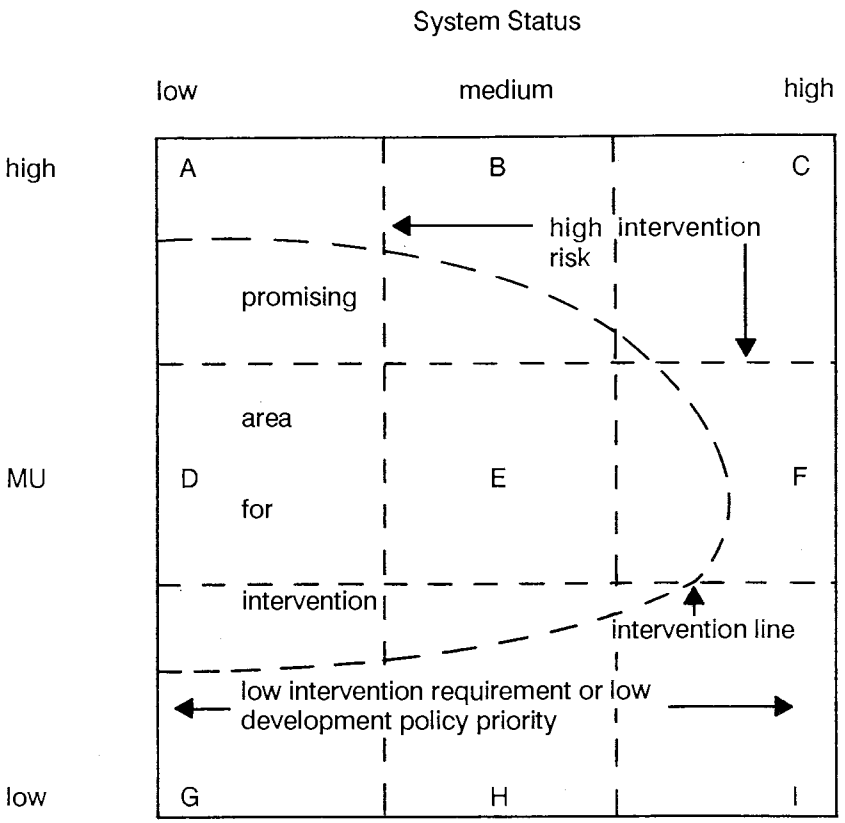
> On management criteria, intervention by the donor should as far as possible be restricted to the area enclosed by the intervention line.

In practice, the intervention line **does not**, of course, represent a **sharply defined boundary**. It is, however, useful as a broad indication of the transitional zone between promising and less promising situation areas.

It follows that the areas outside the intervention line cannot always be avoided. This is mainly due to the **fact that development cooperation is based on an application from the potential recipient country**. Thus, for example, an existing irrigation project may be located in the area of high system status and high uncertainty (upper right-hand field C of the matrix). Alternatively, a new project might have to be located in this area for political reasons.

One task of project **management** will, however, be to define a suitable management strategy for shifting the project to a more **management-favourable** situation area **inside the intervention line, so far as the particular situation permits**. Management strategy will therefore be to take appropriate measures to **reduce the system status** and at the same time

Fig. 7: Intervention Line for Development Cooperation on Management Criteria

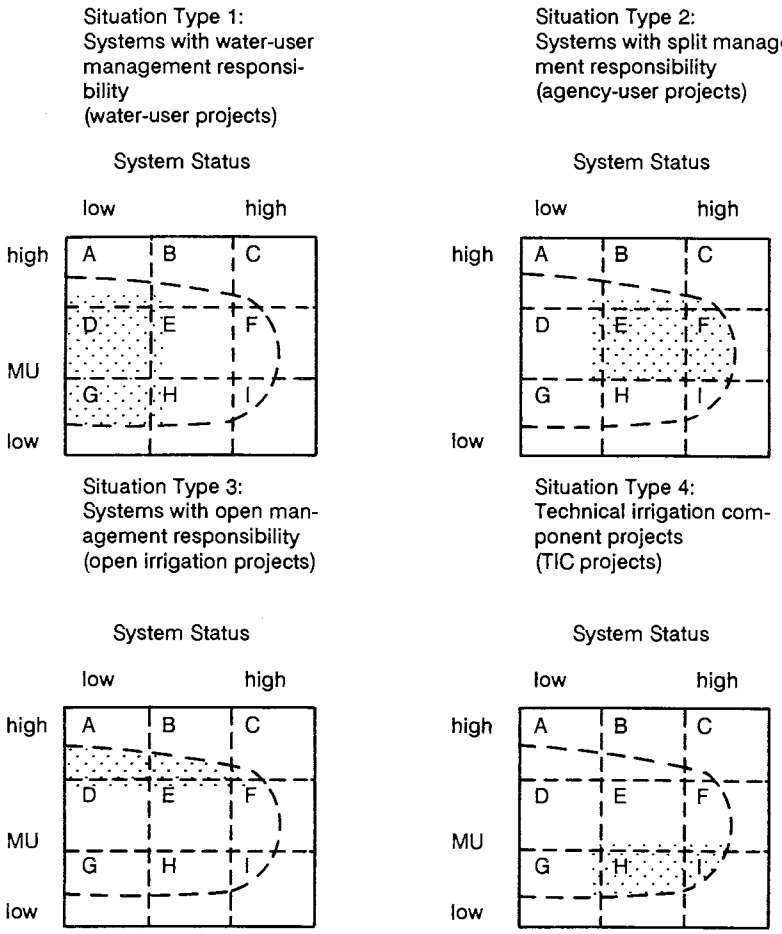


decrease management uncertainty. In the example given above, this would mean leaving Field C and moving to Field E or Field F.

The next section (**Chapter 4.4**) defines the **situation types** referred to above. Situation-specific project concepts for these types will be developed later (**Chapter 5**).

4.4 Differentiation of Situation Types for Irrigation System Management

Fig. 8: Four Situation Types as a Basis for the Derivation of Management-Specific Project Concepts



See Figure 7 for position of intervention line.

Figure 8 shows the four **situation types** which are to be used for the purposes defined in these guiding principles. This section briefly localizes and defines these four situation types, initially using the matrix fields (cf.

Overview 2 and **Overview 3**). The criterion used to define the situation types is one of great practical importance for system management: **the distribution of management responsibility**. It enables the four situation types to be characterized as follows:

- **Situation Type 1**: This situation type essentially coincides with **Field D** and part of **Field G** in the matrix. It is characterized by the allocation of management responsibility primarily to the **water users** (water user projects).

- **Situation Type 2**: This type coincides mainly with **Field E** and part of **Field F**. It is characterized by **split management responsibility*** (agency-user projects).

- **Situation Type 3**: This type covers the lower halves of **Fields A** and **B** and partly overlaps with Types 1 and 2. It is distinguished by **open management responsibility**, i.e. the eventual distribution of management responsibility is decided only in the course of an intervention (open management projects).

- **Situation Type 4**: This type begins at the bottom edge of Situation Type 2, covering **Fields H** and **I**. As in Situation Type 2, management responsibility is divided, but intervention in this area is distinguished from that in Type 2 by the low management uncertainty involved (technical irrigation component project).

Like the intervention line itself, all four situation types represent **not sharply-defined zones**, but **fluid transitions** both to areas outside the intervention line and between the individual situation types.

4.5 Function and Range of Applications of the Matrix

What is the function of the matrix in regard to the design and control of irrigation systems at the **strategic management*** level? How can the matrix be used by the responsible managers? These questions are discussed in this section; the flow chart in **Overview 4** illustrates the major steps for the reader.

Basically, the matrix fulfils two functions:
a. It is an analytical tool;
b. It is a planning tool.

ad a) As a **tool of analysis** the matrix can be used in **existing irrigation projects**, where it helps to answer the question:

> What is the current situation of the system in terms of **management requirements**?

The contingency factors on which the matrix is based play a decisive role in answering this question. The manager must attempt to assess the individual contingency factors for his particular case and locate them on the relevant spectrum (e.g.low-high). The factors are then combined in the two factor sets of system status and management uncertainty. The combinations of individual contingency factors yield an **overall assessment of the two factor sets within their respective spectra** (e.g. medium system status and low management uncertainty). Only after making this assessment can the manager roughly determine the location of the project in the matrix. He or she can then establish whether it lies **inside the intervention line** and, if so, **to which situation type it should be assigned**.

In certain instances, localization of the project within the matrix may be relatively simple. This will be the case if the individual contingency factors of a set tend relatively **uniformly** in the direction of low or high system status or low or high management uncertainty.

Localization becomes more difficult when certain contingency factors tend in **opposite directions**. Here, the only solution is for the manager to estimate which factors have higher **priority**. The priority given by the manager to certain contingency factors then finally determines the overall position of the factor set within its spectrum.

Once an approximate decision has been reached as to which situation type applies to an existing system, the manager can use the corresponding management-specific project concept* assigned to that situation type (**Chapter 5**). This project concept is intended to provide advice on **strategic management**. Concrete recommendations for implementing the appropriate project concept can be found in the **set of working aids** for operational irrigation system management.

ad b) As a tool for irrigation project **planning**, the matrix helps to answer the question:

What will be the situation of the irrigation system in terms of **anticipated management requirements** if the project is realized?

In this instance, the procedure is basically the same as that described under a), except that the contingency factor sets sometimes exist only as **options**, which may themselves be the objects of planning. This is particularly true of factors which determine system status. It is thus possible to work with **alternatives**, which may well lead to differing localizations of the project within the matrix. Those alternatives which result in the project's being localized **outside the intervention line** should if possible be rejected.

If there are alternatives **inside the intervention line**, the corresponding project concept indicates the conceptual, management-specific criteria **which should be employed if the project is realized**.

As a planning tool, the procedure described above characterizes the 'manageability' of a project. Indications of this kind are an extremely effective supplement to information on project **feasibility**, but cannot be used as a **substitute** for it.

Any decision on an irrigation project's **feasibility** from the point of view of the local authority and external donor organization must take account not only of the management aspects (**manageability**) stressed here, but in particular, of economic and technical efficiency criteria.

In the next chapter (**Chapter 5**), **situation-specific management principles** and **recommendations for the strategic management of the overall system** are developed for each of the four situation types. The guidelines not only relate to irrigation sector **projects** but analyze these projects exclusively in terms of **conceptual aspects of management,** Chapter 5 therefore provides four **model management-oriented project concepts** for development cooperation.

These four model management-related project concepts may be characterized as follows:

- **Project Concept 1** (**Chapter 5.2**) covers projects in which responsibility for **ensuring the sustainability of the project rests with the water users**. They possess the necessary performance potential to operate the system **autonomously**. The water authority is, however, important to the success of the system as a whole because of the **services** it provides for the water users.

- **Project Concept 2** (**Chapter 5.3**) covers projects in which **management responsibility** is **shared** between the water authority and the water users. The **sustainability*** of the project's impacts must be ensured by both parties, with the authority covering certain central areas of responsibility in all cases.

- **Project Concept 3** (**Chapter 5.4**): if neither the water authority nor the water users possess adequate performance potential, the **institutional base** for further measures in the irrigation sector will need to be created (institutional development). Following successful intervention at the institutional level, projects of this type will develop in the direction of either Concept 1 or Concept 2, depending on the situation.

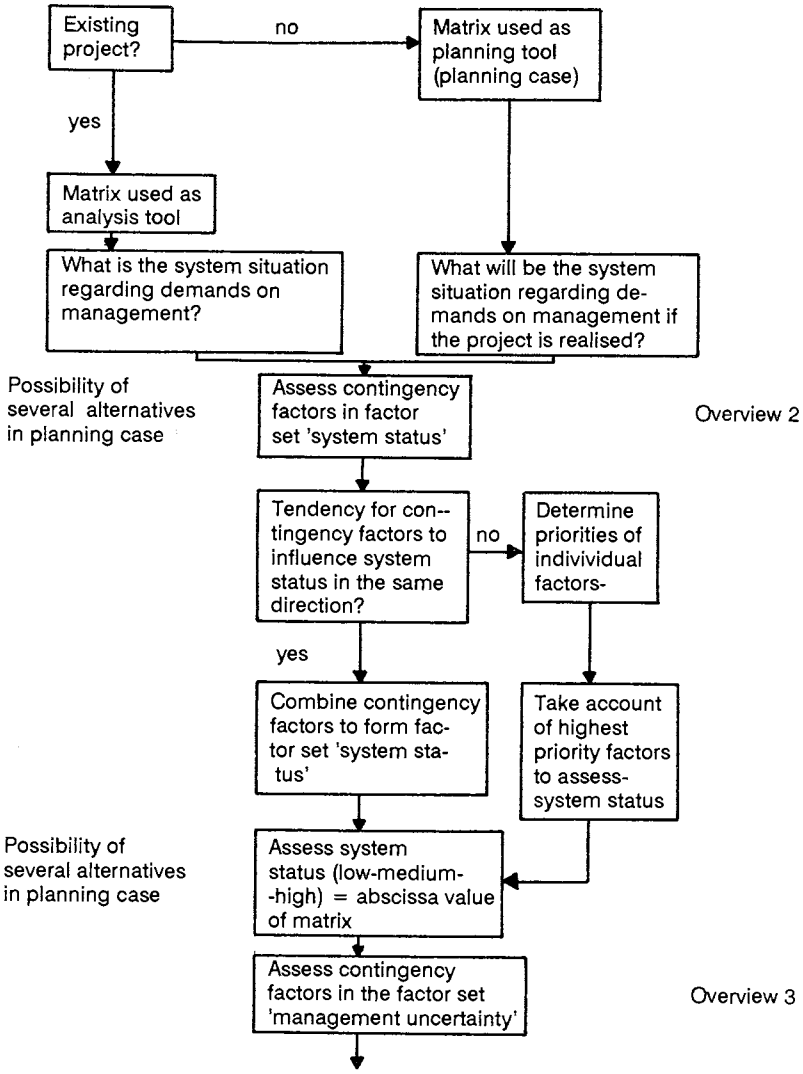
- **Project Concept 4** (**Chapter 5.5**) relates to projects in which **physical** or **material components of the irrigation system** are established with the assistance of the donor organization and transferred to the water authority immediately after completion, with no accompanying consultancy services. Although management responsibility in this type of project is divided, the water authority normally assumes responsibility for the proper use of the completed technical component.

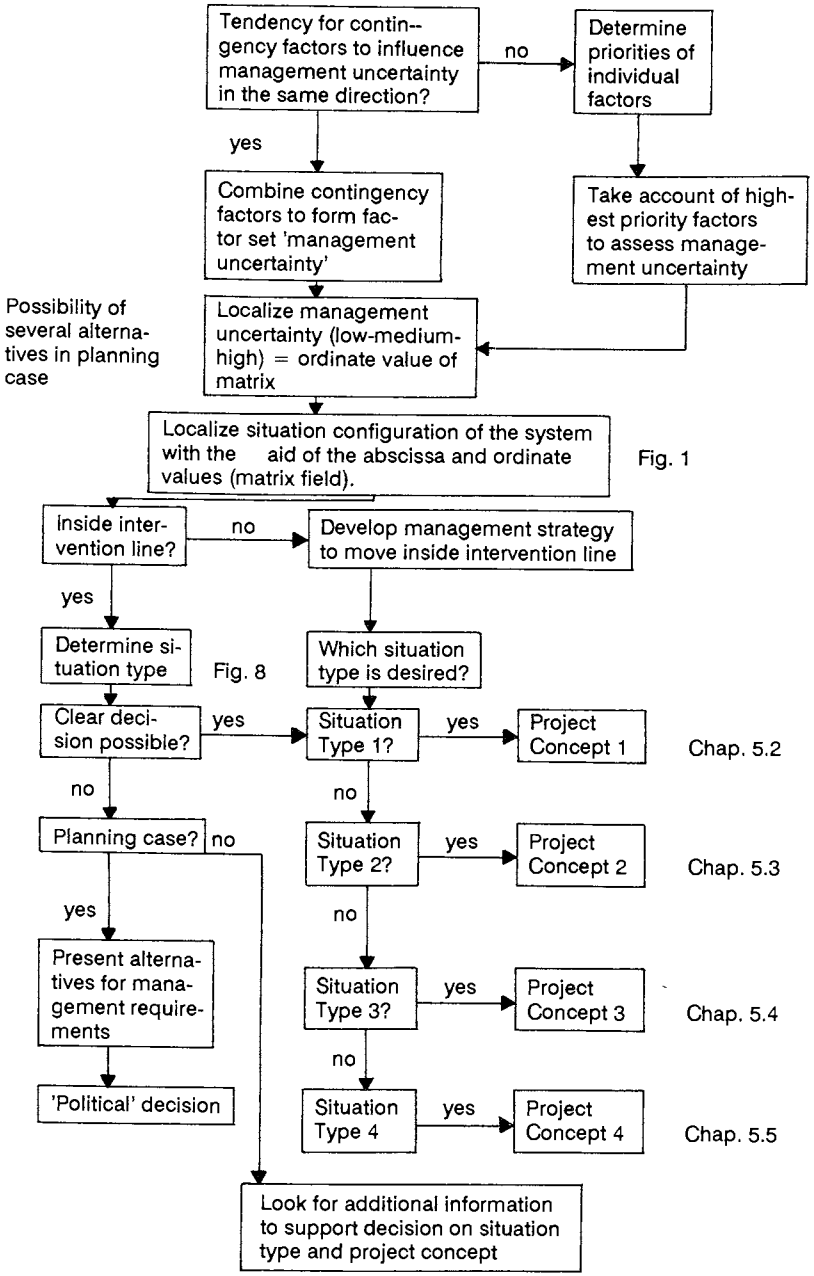
Summary Chapter 4 (Terms marked with an asterisk are defined in the glossary).

- The chapter aims to reduce the wide spectrum of conceivable situation sets in irrigation systems* in accordance with the management* requirements of these systems.
- In these guidelines, the spectrum of situations is narrowed on **exclusively management criteria**.
- Contingency factors* which have proved especially relevant to the design and control of irrigation systems are selected.
- Contingency factors which tend to have similar effects on management are grouped together to form the **factor sets** 'irrigation system status' (**Overview 2**) and 'management uncertainty' (**Overview 3**).

- These two factor sets mark the axes of a two-dimensional continuum. This continuum is represented as a matrix covering the entire field of potential management-specific situational configurations (**Figure 1**).
- The aim is to find the area of the matrix within which conditions for successful management in a development cooperation framework are relatively favourable. This area is delimited by an **intervention line***.
- Four criteria are used to localize the intervention line within the matrix: management-specific requirements imposed on development cooperation agencies*, the recipient country's need for external support, the main performance potentials of the donor organizations, and the development policy objectives of the donor country.
- The areas outside the intervention line represent situations which must be seen as particularly critical for successful irrigation system management in development cooperation.
- Where possible, donor organizations should avoid venturing outside the intervention line in their choice of projects.
- On the basis of existing experience of development cooperation irrigation projects, four **situation types** inside the intervention line are defined (**Figure 8**); management-related project concepts are offered for each of these in **Chapter 5**.
- The matrix developed in **Chapter 4** can serve decision-makers either as either an **analytical** or a **planning tool** determining the current or future matrix location of a project* in terms of the management-specific situation.
- The discussion in **Chapter 4** indicates the current (analytical tool) or prospective (planning tool) **manageability** of an irrigation project. These indications are not a substitute for information on the fundamental **feasibility** of a project, but can effectively supplement it.

Overview 4: **Flow Chart of the Procedure for Defining Situation Types for the Management of Irrigation Systems**





5. Management-Oriented Project Concepts for Irrigation Development Cooperation

5.1 Introduction

In **Chapters 5.2** to **5.5**, an appropriate **project concept*** will be developed for each of the situation types defined in **Chapter 4** with the aid of management-specific contingency factors. There will be detailed clarification of each of the following questions .

- What are the **attributes** of a specific project concept in relation to dividing management responsibility between the water authority and the water users' organization and to securing the sustainability* of the project's impacts? This includes determining the specific manage- ment requirements stemming from the desired **management cooperation*** between such varied groups as water users, water authorities and external donor organizations.

- What **management principles** should apply to the chosen project concept, especially with regard to the continuum between product- oriented and service-oriented performance contributions?

- What specific **sequence of project phases** will be best suited to the given situation configuration? There will be distinct sequences of pro- ject phases for each project concept, differing considerably in terms of both the classic project preparation/planning/implementation sequence and the management tools and methods usually employed.

5.2 Conceptual Aspects of Irrigation System Management With Predominant Water User Management Responsibility (Water User Projects)

5.2.1 Management-Specific Attributes of Water User Projects

Water user projects represent a response to **Situation Type 1** (**Figure 8**):

- there is **low system status** (cf. **Overview 2**)

– the projects lie in the range of **medium to low management uncertainty** (cf. **Overview 3**).

The decisive principle underlying water user projects is that the water users* should be able to manage and operate the entire system autonomously in the long term.

The pre-condition for this is that the water users should possess **adequate performance potential***, i.e. especially that they have traditional irrigation experience. Only if this condition is met can water users be helped to attain long-term management autonomy within the usual project time-span.

In projects of this type, governmental or private organizations in the irrigation field assume the long-term role of **service institutions** providing the autonomous water users with the desired resources and advisory services. In reality, however, irrigation agencies are generally oriented towards the creation and maintenance of the necessary hydraulic infrastructure, and assume the status of a **technical** execution agency. If such organizations are to be enabled to undertake social organization and technical service functions for autonomous water users' organizations, **structural and conceptual adaptation** will be necessary. These may occur within a framework of more or less extensive **re-organization** of the relevant agencies.

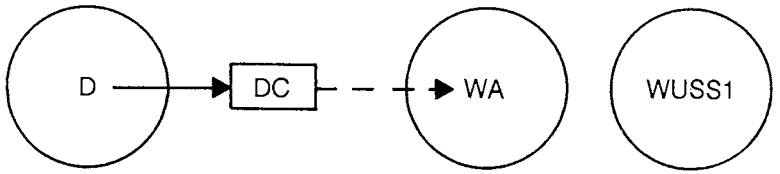
Figure 9 shows successive **model** stages of such an adaptation process and indicates the phases of cooperation between the water users, water authority and donor organization*. The stages may be defined as follows:

1) The donor organization usually becomes **involved** in the irrigation system* via the local project executing agency*. The development contribution is integrated in the existing water authority so as to provide optimum support for its planned measures (the project*) or to enable them to take place.

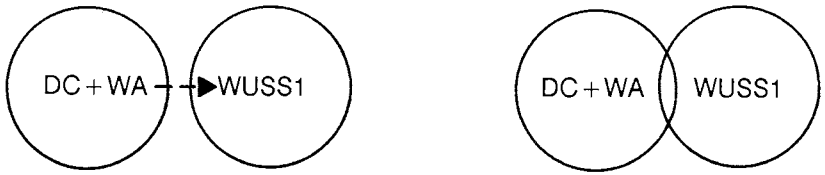
2) In the **second stage**, the objective of management cooperation between the water authority and the donor organization is **to strengthen the performance potential of the water users**, a goal achieved through joint action research* by all participants. During this process, the water authority **re-organizes** itself to perform its future **service functions**. The traditionally technical orientation of the water authority is replaced by a **socio-technical* orientation**.

Fig. 9: Model Stages of Management Cooperation in Water User Projects

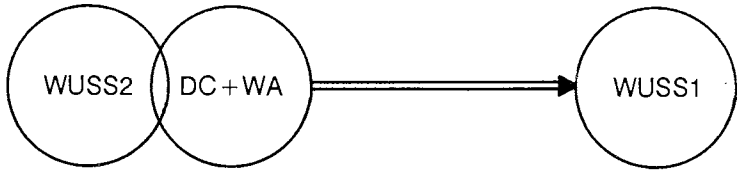
Stage 1: Incorporation of DC in selected WA; adaptation between DC and WA



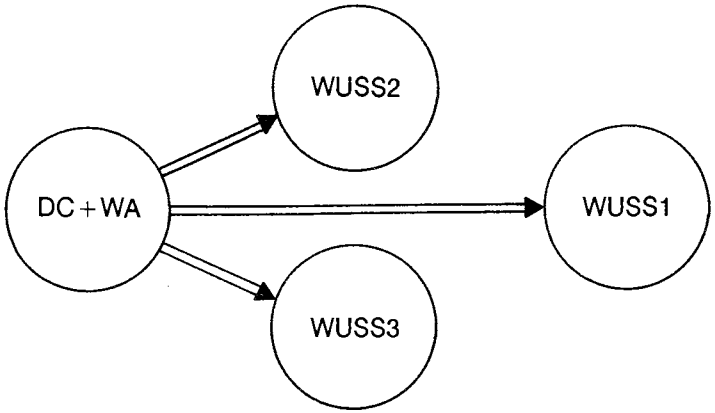
Stage 2: DC + WA action research in cooperation with WUSS1; mutual familiarisation; re-organisation of WA; strengthening of WUSS1



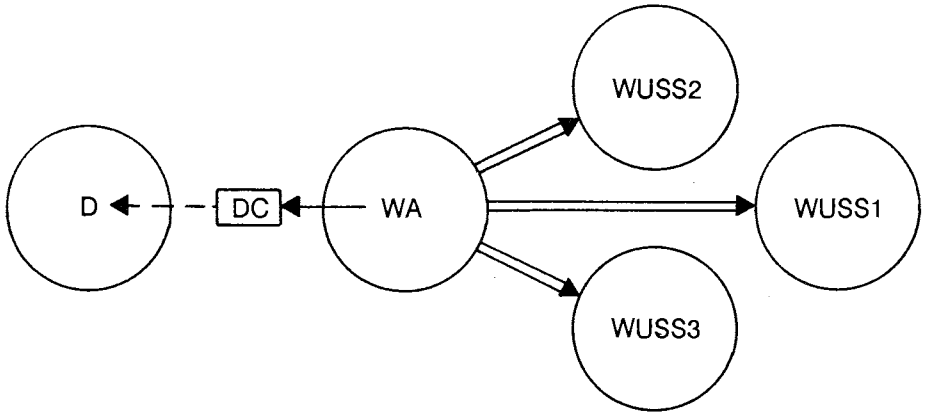
Stage 3: Withdrawal of DC + WA from expert technical services for WUSS1; action research with WUSS2, WUSS3, etc.



Stage 4: Extension of WA services to include WUSS2, WUSS3, etc.; regional differentiation of WA as required



Stage 5: Termination of DC; termination of project; services by WA to autonomous WUSS



DC = Development contribution of external donor organisation
WA = Water authority
WU = Water users
SS = Sub-system
D = Donor organisation

3) In the third stage, the water authority restricts its role to offering services to the established water users' organization. Services range from technical assistance to provision of **inputs and capital**. At this stage, external experts support the water authority in performing its **service function** and stabilize it in this role.

In the case of water user projects, water authorities will rarely be dealing with only **one** (small) perimeter, but will receive demands for their services* from **numerous other water-user systems with comparable system status** within a region. In the third stage, the water authority extends its action research to the other water user systems , with the aid of the donor organization, thus enlarging its clientele.

4) In the **fourth stage,** the water authority offers its services to all developed water user systems. At this stage, an external development contribution comprising both know-how transfer and - primarily - inputs is still necessary, as it will still be difficult to ensure adequate mobilization of local resources for the water authority.

5) In the **fifth stage,** the donor organization prepares to complete its development contribution and withdraws from the project. The water users must now operate the irrigation systems autonomously and the water authority's service functions must be firmly established.

The **stages of development** in a water user project outlined above correspond to the phases of cooperation between the participating organizations. These stages unfold alongside the **project phases*** of the planning and implementation sequence discussed in **Chapter 5.2.4**.

5.2.2 Management Principles of Water User Projects

In this type of project, the performance contribution of water authorities is concentrated on providing services to autonomous water users. Apart from the technical competence of the water authority, social relationships between water authority staff and water users are a factor of the utmost importance in the design of water user projects. The external project contribution should therefore help to establish a **learning process** between the two sides.

Planning and implementation of the project must be organized to allow for this learning process. The following points deserve special attention:

a) The development of the performance potential of the water users must be **concurrent** with physical infrastructure development, e.g. construction and repair. This implies that creation or rehabilitation of the physical infrastructure should take place only with the prospective water users' **active participation**, in the form of joint planning and design supplemented by labour and financial contributions (participatory approach). This participation can, however, be ensured only if the prospective water users already view themselves as the user group and therefore exert a certain degree of social pressure on group members who are reluctant to participate. For the water authority, the implication is that even during the project identification phase the problem of organizing the future users must be faced, taking advantage of existing farmers' groups and organizations as far as possible.

b) A pre-requisite for tackling this question is detailed knowledge of the situation* affecting the water users, in which the irrigation project will be integrated. **Data collection** is needed to familiarize the water authority staff with this situation. In line with the participatory approach, data collection should take the form of **action research** in which **water authority** personnel should participate.

This transforms data collection into a **tool** of management cooperation* between the water authority and water users and - apart from achieving a reciprocal learning effect - serves as a basis for joint creation of the infrastructure and the water users' organizations. The responsible water authority should **not,** therefore, delegate data collection work to other institutions, since the desired learning effect would then be lost and the water authority would lose the basis for participation. The water authority should create the necessary organizational capacity to carry out research of this kind itself, and use it as a standard working tool.

5.2.3 Qualifying Irrigation Organizations for their Role in Water User Projects

5.2.3.1 Principles for Qualifying Water Authorities for their Role

All the steps referred to above assume that there is a water authority capable of initiating and successfully supporting the necessary expansion of water-user performance capacity and then providing efficient services to the water users' organizations created. Such a capability seldom exists. The primary goal of water user projects in development cooperation must therefore be to enable the existing water authorities to fulfil this task through appropriate **development of their capacity.**

The main aspects of water authority qualification will therefore be:

a) **Staff:**

- The water authority requires staff whose knowledge is not restricted to 'classic' technical know-how on the hydraulic infrastructure and water distribution. Since the users of the technology are small farmers, who will in the long term have to operate and maintain the system autonomously, the water authority staff should contribute situation-specific knowledge **of appropriate technological solutions.**

- The intensive and essential **social relationships** between the water authority staff and the water users demand a fundamental readiness and ability from the field workers to conduct discussions with water users, work together with them and learn from them. These abilities should not be regarded as self-evident; they must be created by means of situation-oriented training courses.

- The fieldworkers should not only act as irrigation and production advisers, but assist in the development and consolidation of water users' organizations. This requires **specific skills in the organization of user groups**. Only very rarely will the water authorities in irrigation systems possess adequate experience and skills, since problems of group formation have hitherto been largely ignored by water authorities and external donor organizations.

b) **Organizational Design**

- In water user projects, the water authority serves a large number of small, widely scattered systems. This situation demands regional decentralization of water authority responsibilities for measures carried out in direct interaction with the water users.

- One consequence of regional decentralization is that water authority staff need to live near their clients, i.e. in the irrigation system area. This means that management must develop specific motivational strategies, with incentives to compensate for more difficult living conditions.

c) **Planning Capacity**

- An important task of the water authority is technically **and** socially adapted planning of the hydraulic infrastructure. **Participatory** planning, usually a completely new concept for the agency, is required.

d) **Goal System**

- Since the irrigation systems involved are relatively small, the small farmers' **basic-needs and risk-avoidance strategies** must be taken into account.

5.2.3.2 Principles for Qualifying Water Users for their Role

All measures to qualify water users start with the existing performance potential of this group at the beginning of the project. The most comprehensive possible analysis of the available performance potential is desirable, in order to increase water user potential.

It should, however, be emphasized that conventional methods of analysis are of limited use in determining the performance potential of a social system of the kind represented by the water users. The factors relevant to an understanding of the function of social systems can frequently be identified and described only in a process of **interaction with the system,** i.e. through concrete work within the system. An improvement of the water users' performance potential must therefore be seen as a process in which all responsible for the project observe the reactions of the social system and so gain a knowledge of its weaknesses as a basis for future work.

The following aspects are of particular importance in this interactive process:

a) **Knowledge and Skills:**

- For water users to assume management responsibility, they must be equipped with the specific **technical** knowledge and skills required for the construction, operation and maintenance of the hydraulic infrastructure.

- The water users need detailed knowledge of the **philosophy and working procedures of the water authority** and the services it offers. It is important for participation that the water users should also come to know and understand the restrictions under which the water authority has to work. This helps them to make a realistic estimate of the water authority's capabilities and creates the trust necessary for social relationships.

- Not only must the staff of the water authority learn to communicate with the water users; the water users will also often have problems in communicating with representatives of the water authority. Recognizing that these difficulties stem from farmers' widespread mistrust of government institutions, project management must try to encourage dialogue with the water users through **confidence-building measures**.

b) **Organization**:

- In the initial stages of the project, organization of the water users should be oriented primarily towards the factor 'water' and the associated functions of water acquisition and distribution. In later project stages, additional 'non-water' functions not offered as long-term services by the water authority may be assumed by the water users.

- In most cases, water users' organizations in this type of programme will be relatively **small** groups of a rather informal and organic character. There are strict limitations on formalization from outside the group.

- If water user projects are to be operated autonomously in the long term, water users' groups must be enabled to assume long-term responsibility for the following tasks, taking traditional social structures into account, i.e. they must be enabled to

  - create, maintain and rehabilitate the infrastructure,
  - organize water acquisition,
  - organize the distribution of water between water users,
  - resolve conflicts,
  - mobilize and administer financial contributions from the users,
  - mobilize users' labour contributions.

- Any existing functional water users' organizations in the system environment of the envisaged project must be subjected to close examination. A transfer of the organizational solutions encountered will,

however, be possible only if the situational configurations are similar to those encountered in the project.

5.2.4 Attributes of the Planning, Implementation and Operation Phases of Water User Projects

Cooperation between the water authority and the water users in the form of a reciprocal learning process based on action research is a relatively open and time-consuming process. A donor organization cannot therefore effectively support this process through conventional planning and implementation procedures. Rather, the design and scheduling of water user projects must be characterized by **flexible goal, resource and time specifications**.

The following sequence (see **Overview 5**) of project identification, planning, implementation and operation may be seen as a situation-adapted procedure for water user projects - contrasting with the 'classic' phases of

a) Project identification,
b) Project planning,
c) Adaptation (re-organization) of the water authority within the framework of action research,
d) Decentralized operational planning (implementation planning),
e) Decentralized implementation of each irrigation system.

ad a) The irrigation systems constructed under a water user project should in the long term be managed by the water users themselves. Project identification for this project type should therefore be based on partnership with the future water users from the beginning. In view of the usual distinct water authority orientation towards **technical** aspects of irrigation, with a corresponding neglect of social and organizational questions, agreement between the water authority, the water users and the donor organization on the unfamiliar **participatory procedure** must be achieved at the project identification stage.

Project identification starts with a **situation analysis**, which should establish that a water user project **fundamentally** promises success. From a **technical** point of view, the following points must be clarified:

- Can the **performance potential*** of the water authority be developed during the project to a point where it can provide the necessary long-term services?

- In the view of the engineers, do prevailing conditions allow the hydraulic infrastructure to be engineered for autonomous operation by the water users?

- Is the organizational **ability** of the water users adequate? This aspect cannot be clarified without a deeper understanding of the **social system** of the water users. **Action research** is a useful tool for gaining such understanding.

ad b) Project planning is oriented on the stages shown in **Chapter 5.2.1 (Figure 9)**. The main emphasis of project planning is on Stages 1 and 2. Project planning can thus be concentrated on one **example** of the interaction between the water authority and a water users' sub-system (WUSS1 in **Figure 9**). Of central interest is the planning of the action research process, and the accompanying re-organization of the water authority. In the project planning phase, it is useful to treat **user-related** measures (creation of the **infrastructure** and the **water users' organization)** and **agency-related** measures (**institutional development*** of the agency) separately.

In addition to detailed planning of Stages 1 and 2, project planning must also lay the groundwork for measures necessary in the subsequent Stages 3 to 5. This mainly involves rough planning of water authority decentralization to match the increasing number of water user systems.

ad c) Where the previous work of the water authority has concentrated chiefly on providing an infrastructure, re-organization may be necessary during this phase. This re-organization should take place while the hydraulic infrastructure is being constructed and the water users' organization is being set up. The water authority's managers are responsible for this process, with conceptual, material, financial and organizational support from external specialists.

In the typical sequence of stages, the water authority will initially concern itself with **one** irrigation system. On the one hand, this results in joint construction of a hydraulic infrastructure and a gradual increase in the water users' responsibility for the management of the system.

On the other hand, cooperation with the water users and supplementary training prepares the water authority staff to deal with the altered requirements of their job. They should see themselves as **advisers to the water users**, and should be qualified to participate with them in implementing

problem-specific technical solutions. Action research methods may help to ensure continuous monitoring of outcomes and the modification of future actions in line with previous results.

d) The water authority adaptation phase passes directly into decentralized **operational planning** of single water user systems. Operational planning is based on experience gained in the process described in Phase c). In addition to planning participatory design and construction of the infrastructure, operational planning must also concentrate on the phase when the system is in full operation (**operating phase**). The operation plan establishes the steps required, which need to be implemented by the water users' organizations with support from the water authority irrigation and donor organization.

Operational planning must pay particular attention to the planned transfer of responsibility to the water users in the individual systems. Since this transfer depends decisively on the extent to which the desired service capacity can be successfully created in Phase c), time schedules under operational planning must remain flexible.

e) On the basis of operational planning, decentralized implementation of measures can begin as soon as the water authority has acquired sufficient institutional capacity from experience with the initial irrigation system (WUSS1 in **Figure 9**). Extension of the water authority's area of responsibilities to include further regionally-distributed irrigation systems leads to greater strengthening of institutional capacity.

At the same time, however, there is a growing demand for financial and material resources, since each additional system requires construction or rehabilitation of a hydraulic infrastructure. With the regional expansion of water authority activities in this phase, the staffing contribution of the donor organization is reduced in relation to material and financial inputs.

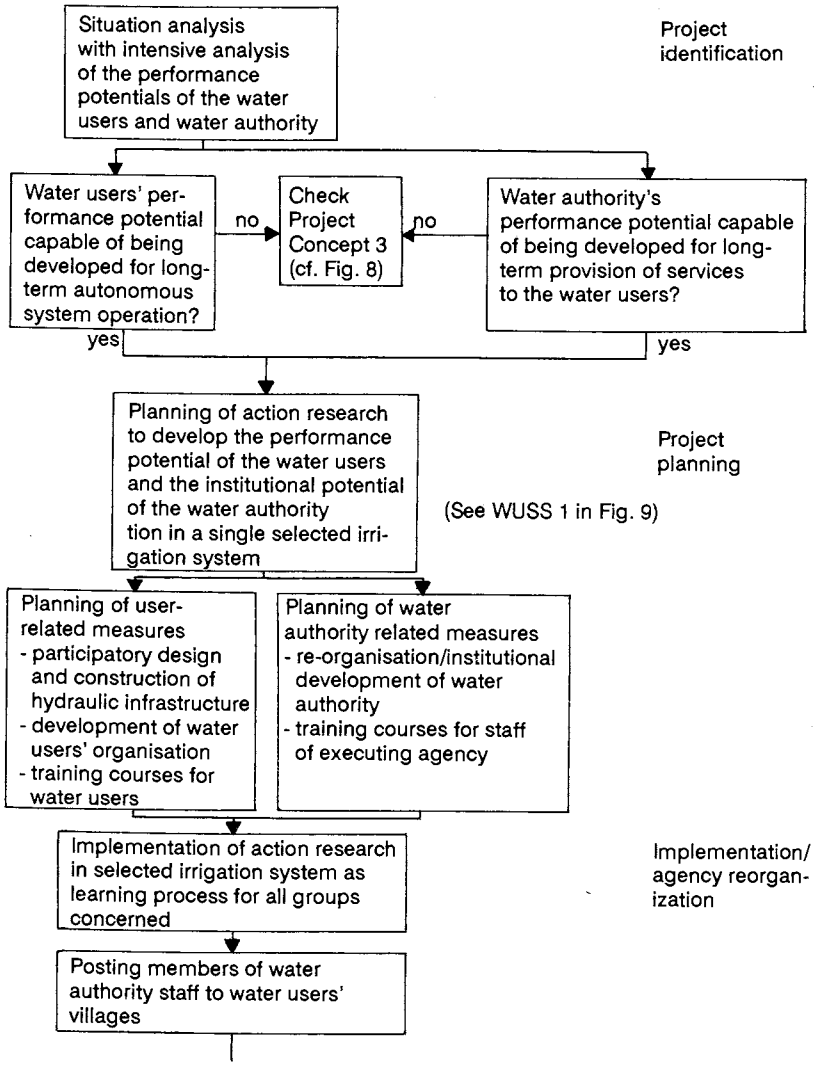
A warning should, however, be given against reducing staff support too early, since an exceptional amount of controlling work may be expected in the implementation and operation phases, owing to the necessary decentralization of the water authority.

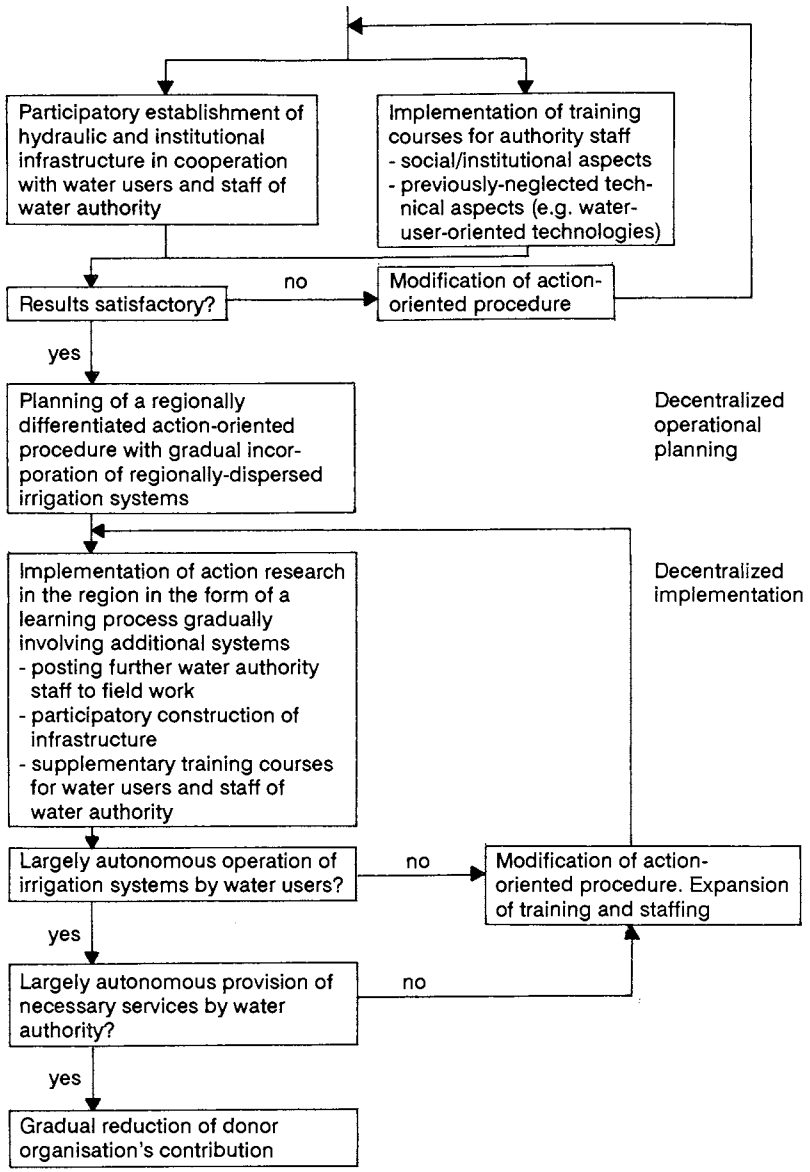
Summary Chapter 5.2 (terms marked with an asterisk are defined in the glossary).

Situation Type 1: Water User Projects (WUP's)

- WUP's lie in the range of low system status (**Overview 2**) and medium to low management uncertainty (**Overview 3**).
- The decisive principle underlying WUP's is that water users* should in the **long term** be able to manage the system autonomously.
- The pre-condition is that the water users should have a certain degree of experience in irrigation which can be expanded during the development project to provide the necessary performance potential*.
- The local water authority* should cooperate in strengthening water users' potential, as part of the project, and should in the long term provide **services*** to the autonomous water users.
- The primarily technical orientation of water authorities must be abandoned in favour of a socio-technical orientation, achieved by means of appropriate **structural and conceptual re-organization.**
- Methodologically, this re-organization should be carried out in the form of a learning process between the water authority and the water users (**action research***). Knowledge of the way in which the water users' social system functions can often be acquired only through participation in the system.
- In order to ensure close cooperation between the water authority and the water users in the **participatory construction** of the hydraulic infrastructure, the water authority should consider posting its staff to the villages of the water users. The staff concerned must receive special training familiarizing them with action research methods and with the fundamental social and institutional problems of the water users.
- The project phases* of a WUP might be as follows: project identification, project planning, re-organization of the water authority as part of action research, decentralized operations planning, decentralized implementation of individual irrigation systems.

Overview 5: **Flow Chart - Planning Concept for a Water User Project (Project Concept 1)**





5.3 Conceptual Aspects of the Management of Irrigation Projects with Divided Responsibility (Agency-User Projects)

5.3.1 Management-Specific Features of Agency-User Projects

Agency-user projects represent a response to **Situation Type 2** (**Figure 8**):

- they lie in the range of **medium to high system status** (cf. **Overview 2**),
- they have **medium management uncertainty** (cf. **Overview 3**).

The fundamental principle underlying agency-user projects is that

> management responsibility is divided between the water authority* and the water users*. Sustainability* of project impacts can therefore be guaranteed only through concerted action by both groups.

The pre-condition for the division of management responsibility is that the water authority should possess a **performance potential*** which offers a high probability of development to the required level within acceptable project time-schedules.

If this condition is not satisfied, the situation sets correspond more closely to **Situation Type 4** and demand a project concept* with open management responsibility (**Figure 8**).

For the successful implementation of this project concept, it is an advantage for the water users to possess **experience of irrigation**, at least some experience in the organizational field being especially desirable.

Agency-user projects will usually be systems with an irrigated area up to several tens of thousands of hectares. Several operational levels* and a large number of water users are to be expected under such circumstances. Experience shows that irrigation systems* of this size generally require a specialized unit for main system management, which **can rarely** be provided by the water users themselves.

In development cooperation* practice, the responsibility for **overriding system management** therefore always devolves upon a water authority of some kind. Apart from general planning and control of the overall system, this applies particularly to the management of water acquisition and water distribution in the **main canal system**.

The problems confronting the management of large irrigation systems have in the past often led to the water users being denied even the slightest responsibility for joint management of the system. The following **tendencies** are observed in water authority behaviour, the trend being the more pronounced the **greater** the numbers of operational levels and water users:

- The responsible water authority attempts to control the entire system 'from the top down'. As far as possible, planning, organization and monitoring at **all** operational levels are carried out by the water authority.
- The water authority tries to acquire the greatest possible influence over the **management of individual production units** (choice of crops, crop rotation, fertilizers, marketing).
- Where system management is involved, water users are seen as members of the system playing a mainly passive **implementational** role. Water user participation in water authority decisions is envisaged only to a small extent, or not at all.
- The **goal system** of the irrigation project is oriented principally towards **government interests and objectives**, which the water authority imposes on the farmers. Production targets are oriented chiefly towards export and domestic cash crops. Water users' basic-needs and risk avoidance requirements are not sufficiently taken into account.

In developing countries, these aspects of management are frequently the result of a similar development policy, but are hardly in tune with current development policy objectives. From a development cooperation point of view, projects with this type of situation configuration require intervention to re-emphasize the **role of the water users** and their **needs and goals**, in accordance with the poverty and target-group orientation of development policy (cf. **Chapter 4.2.3.3**).

Apart from these development policy factors, other arguments also favour stricter orientation of the management of large-scale irrigation systems towards the water users:

- In view of the **financial** difficulties in which many developing countries find themselves, the high **recurrent costs** for the operation of irrigation systems, especially in the **maintenance** sector, cannot continue to be met solely from the national budget. Experience indicates, however, that the **mobilization of resources** from the water users, in the form of financial, material and physical contributions, is successful only if the water users are included in the management process.

- Large irrigation organizations are not capable of effective controlling down to the level of field outlets and canals. This is due partly to the limited number of competent staff available to water authorities in developing countries, and partly to the decreasing ability of an organization to react rapidly and flexibly to its system environment as its size increases.

The inference from all the above points is that

> the design and control of authority user projects must aim to give water users a share of management responsibility, and thus allow them to participate in irrigation system management decisions.

In development cooperation terms, the demand for water user participation reaches its limits when systems are too large and too technically complex to be constructed and operated by the water users alone. This applies to the project type under discussion. Experience indicates, however, that government-constructed irrigation systems are seldom accepted by water users as originally envisaged. Agency-user projects need to awaken the interest of the water users in the system by gradually enabling them to participate in system management, starting at the field canal level.

5.3.2 Management Principles of Agency-User Projects

Basically, agency-user projects must work from both ends of the 'responsibility spectrum': both the water authority and the water users must be made **technically and organizationally** capable of:

- competently performing the management functions assigned to them,

- cooperating efficiently in areas of overlapping responsibility, and minimizing conflicts*.

Water authorities with multipurpose functions have to cover a very **wide performance spectrum**, with great qualitative differences between services. On the one hand, the problems faced by management in planning, constructing or rehabilitating hydraulic infrastructures and in operating certain components favour a **technical** solution and a **production-oriented** management approach (cf. **Chapter 3.3.1**).

On the other hand, the water authority is required to manage the system of **social** relationships in the interests of the water users, and thus to pursue a **service-oriented** management approach. These two types of management must be coordinated methodologically and instrumentally in project planning and implementation.

In many cases, the implementation of agency-user projects will be associated with a need to support an existing irrigation authority (e.g. a ministry) in setting up a **subsidiary organization.** This would take over long-term management of the newly-constructed or rehabilitated irrigation system. If so, planning by the decision-makers must clearly indicate which structures and procedures are **temporary**, and which are designed to fulfil a **long-term** function continuing after project completion.

As far as the **role of the water users** is concerned, greater responsibility can be assumed only via the lowest operational level - the field canal system and the irrigated plots. The point of departure in agency-user projects is hence the creation of **water users' groups**, which should possess the following attributes:

- at the beginning of the project they should be kept as small as possible, to minimize conflicts;

- group membership should be based on the location of field outlets and not on membership in a particular social group (e.g. village);

- activities in the initial phase should concentrate on water distribution within the group and cooperation in maintaining the field canal system.

Assumption of further responsibilities by the water users, for example in irrigation planning and controlling, will be feasible only **when small groups have been functioning over a longer period**.

Water user groups at the field level form the basis for creating a water users' organization which may, in the long term, embrace several hierarchical levels and be able to participate in management responsibilities at each level.

5.3.3 Qualifying Irrigation Organizations for their Role in Agency-User Projects

5.3.3.1 Principles for Qualifying Water Authorities for their Role

In agency-user projects, the task is not only to support a water authority by exploiting external know-how and material inputs to construct new technological infrastructure components(such as distribution structures). Such projects also aim at a **gradual experience and learning process**, equipping the water authority with the necessary long-term ability to:

- carry out partially or wholly autonomous **infrastructure planning and construction**,
- achieve close coordination of **operation and maintenance of the main system** with operation of the field canal system by the water users,
- practise successful **conflict management**,
- strengthen activities directed towards the **mobilization of water user performance potential**. This includes creating the organizational base for optimum **participatory integration** of the water users in planning and operation, and for the desired **resource mobilization**. Part of this base consists of the ability of the water authority to guarantee a reliable supply of water at the field outlet. Apart from organizational questions, this poses the problem of **technical modifications** to distribution and metering devices.

In view of their broad performance spectrum, multi-purpose agency-user projects need a type of employee for their **service-oriented sectors** seldom encountered in classic water authorities in the third world. Staff working in this sector must be willing and able to concern themselves intensively with the situation of the water users, and to learn from them (cf. **Chapter 5.2.3.1**). Their educational or training backgrounds should include a strong sociological orientation as well as a basic knowledge of

irrigation and agricultural production. Some of these employees should specialize in advising and supporting water users in questions of **group formation**.

5.3.3.2 Principles for Qualifying Water Users for their Role

Unlike water user projects, in which water users will in the long term carry out all essential functions within the irrigation system, agency-user projects restrict water user activities to areas not already covered by the water authority. The scope of activities will be different in each situation. However, two main emphases for qualifying water users for their roles emerge :

- There should be an emphasis on transferring **technical know-how** and helping the users to apply it. Qualification of this kind helps to improve efficiency in project sub-systems autonomously planned and operated by water users (e.g. the field canal system).
- Further emphasis should lie on **social and organizational aspects.** Agency-user projects need a framework of organizational rules and regulations for water user activities. This framework must cover at least those operational levels at which the water users are autonomously active as groups. It should, however, extend beyond this technically-determined level in schemes where the long-term aim is **water user participation in general system management**. In many countries, a hierarchy has become established in water users' organizations, whose higher-level representatives can participate successfully in decisions affecting the design and control of the **overall system**.

The improvement of the water users' performance potential during the project must attempt to meet both these criteria. Development cooperation agencies are relatively familiar with questions of **technical training.** The problem lies rather in the creation of a **local extension service** ensuring long-term transference of the necessary technical knowledge and skills even in the absence of outside support.

A future task is to develop situation-adapted tools which will **transfer social and organizational competence** to water users and strengthen their position in participation and communication with the water authority and in building up their own user organizations. Methodologically, the point of departure is action research*, gradually leading to an action-oriented learning process.

Fundamentally, experience in irrigation systems with divided management responsibility has shown that organization of the water users will often be more successful **without administrative compulsion or legal restrictions**. A supportive legal framework may well be useful under these circumstances.

5.3.4 Features of the Planning, Implementation and Operation Phases of Agency-User Projects

Improvements in the performance potential of irrigation agencies and water users within the development cooperation framework are achieved by a process of **competence transfer**. As this process involves adapting social behaviour and organizational procedures rather than transferring technical know-how, it is hard to lay down a fixed time schedule. Its exact content will also depend partly on experience derived from the process itself. For this reason, conventional project planning and implementation with fixed planning objectives are of only limited use in this area.

Agency-user projects should therefore try to attain the desired level of qualifications gradually, through **flexibly formulated goal, input and time specifications** and on the basis of experience actually gained and progress actually made.

The demand for a flexible, sequential planning and implementation procedure for irrigation projects is frequently regarded as unrealistic, especially where a **technically more complex infrastructure** is involved. The fear is that time-consuming sequential procedures combined with capital-intensive construction of a hydraulic infrastructure will make the whole project economically unviable. In response, it should be pointed out that forgoing flexibility and the related chance of planning feedback may entail considerable opportunity costs.

The sequence of planning, implementation and operation phases for agency-user projects is roughly as follows (see Overview 6), taking into account only aspects of special importance from a management viewpoint:

a) Project identification,
b) Master planning,
c) Project planning,
d) Pilot phase,
e) Modified project planning,
f) Project implementation I and II,

g) Project completion.

ad a) The single most important step in **project identification** will be to identify a suitable water authority or assess the performance potentials and project suitabilities of local agencies proposed by the partner. Both these points need to be covered by an on-site **water authority analysis**. Since the water authority will assume only part of the management responsibility, analysis must also include the **future water users**.

In larger-scale projects, two water authorities may be involved, one of which is responsible for **building the infrastructure** and the other for subsequent **operation**. Agency analysis in the project conceptualization phase should be devoted primarily to evaluating the organization responsible for **operation** of the scheme, since this organization - in conjunction with the water users -will have the task of sustaining the project's impacts.

ad b) The preparation of an overall **master plan**, not tied to specific measures, is of importance both for sustainability and for the environmental compatibility of the project. In addition to the integration of envisaged measures in a general **water master plan**, importance should be attached to an agency-related **institutional master plan**. This should, first of all, ensure that the planned activities can be sensibly incorporated in the long-term development of the agency and will not overstretch existing capacity. Institutional planning should also guarantee long-term coordination of the activities of all existing and planned irrigation organizations at regional and national level. The current and planned measures of external donor organizations and the anticipated contributions of water users' organizations must be taken into account.

ad c) **Project planning** must provide the long-term technical and organizational framework for all envisaged measures. In terms of **technical** system design, this will involve - depending on the situation -

- **broad technical planning** of the envisaged infrastructure. This must make clear which measures are intended to promote **competence-transfer** and therefore need to be implemented gradually and jointly with the water authority;

- specification of a **minimum design**, i.e. of those items of the infrastructure which cannot be implemented in any other way, irrespective of the desire for flexibility or planning modifications;

– planning of a **pilot phase** (cf. d), which should permit modification of project planning before large-scale implementation of the planned measures begins.

In addition to technical system design, questions of **organizational** system design play the decisive role in project planning. Unlike **construction tasks** (infrastructure), **institutional development tasks** cannot be planned in the classic sense, since developing the agency and water user organizations is an organic process within social systems, and can be externally supported but not planned in detail. The planning of organizational development tasks will therefore be limited to input planning for support (staff, capital) and flexible scheduling.

ad d) The **pilot phase** is intended to provide all participants with an opportunity to test the viability of the steps conceived in project planning. The irrigated area for the pilot project should be large enough - hundreds rather than tens of hectares - to permit testing not only of the system's ability to function technically, but also of **organizational regulations** and **social processes** embracing all participating groups. For realistic and acceptable results, it is essential that process and learning-oriented methods (e.g. action research) should be used.

If technically possible, the pilot perimeter should not require the implementation of major civil engineering works for the minimum technical design referred to above. This ensures that that the 'zero option' is left open.

In addition, an **internal monitoring and evaluation (M+E) system** should be set up as early as possible, in order to monitor and evaluate the major impacts which occur. One specific monitoring problem in agency-user projects is the partially **non-profit** nature of the water authority, expressed partly in virtually unoperationalizable goals (cf. **Chapter 3.3.4**). The process of water authority and water-user **institutional development** also poses very difficult problems of monitoring and evaluation.

ad e) **Modified project planning** attempts to convert experience and results gained during the pilot phase into detailed project planning. This process must entail close cooperation between the water authority and donor organization, with the participation of groups shown to be important for the success of project work. In all cases, project planning must include representatives of the water users and of the national agencies

to which the water authority is accountable. It is essential that all those planning aspects detailed under Point c) should be reconsidered in the modified project planning phase.

In the **technical field**, modified project planning will finalize infrastructure design, sanctioning no further adaptation during construction and operation, particularly in the case of major, capital-intensive components.

ad f) **Project implementation** will vary according to which of the alternatives discussed at the beginning of this chapter applies to the actual water authority. If the water authority is responsible solely for construction of the infrastructure, this will form **Sub-Phase I** of project implementation. Planning will be fixed, with no claim to transfer competence.

In **Sub-Phase II**, the water authority responsible for **long-term operation** of the system comes into play. Work here will be on the basis of flexible, sequential planning specifications, with the **goal of competence transfer**.

If only a **single** water authority exists, with responsibility for both construction and subsequent operation, the entire package of measures must be designed to allow continuous growth in the water authority's competence .

ad g) **Project completion** should be regarded as an independent phase, since it helps to decide the long-term success of the project. The planning and design of this phase depend to a very great extent on the alternative chosen for the project approach (cf. **Chapter 5.3.2**). If the alternative of a temporary project organization has been selected, detailed planning of the withdrawal of staff resources by and the transfer of project tasks to the parent agency will be particularly necessary. It will then be essential to implement and monitor these steps exactly according to plan.

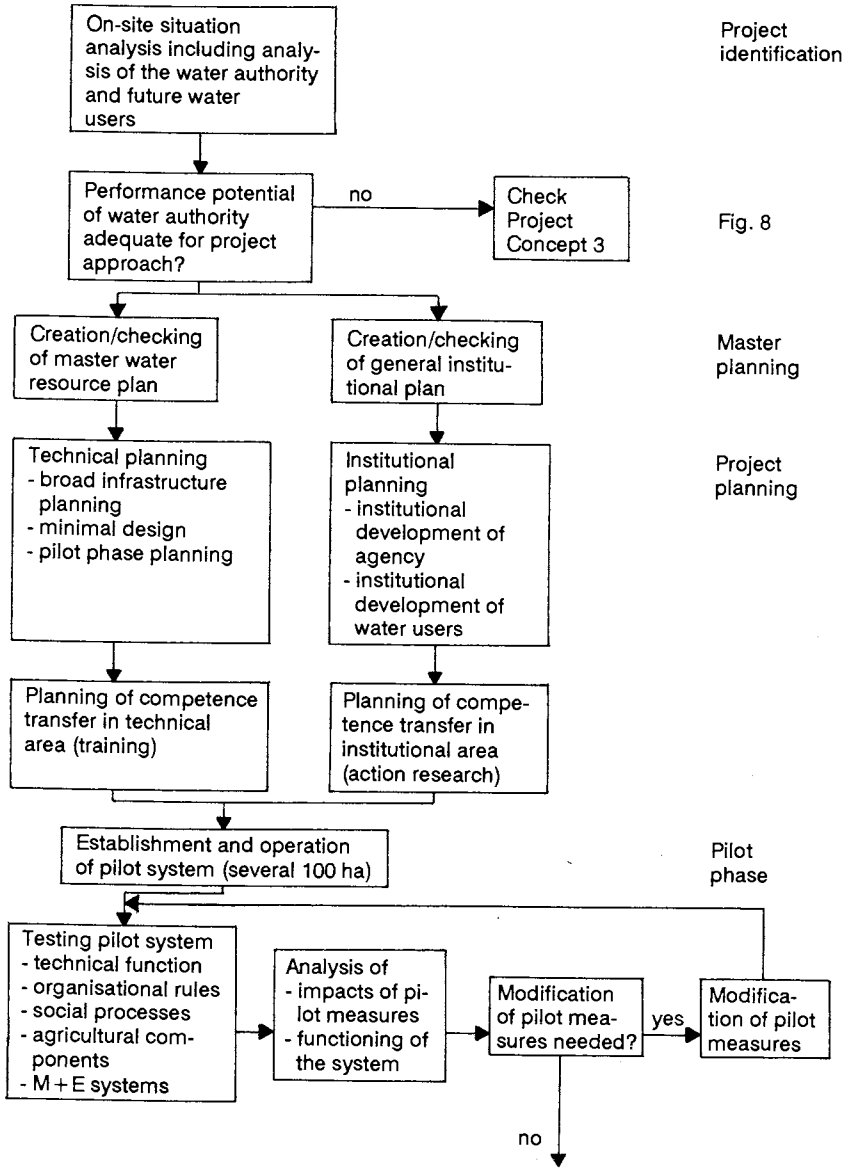
Summary Chapter 5.3 (terms marked with an asterisk are defined in the glossary).

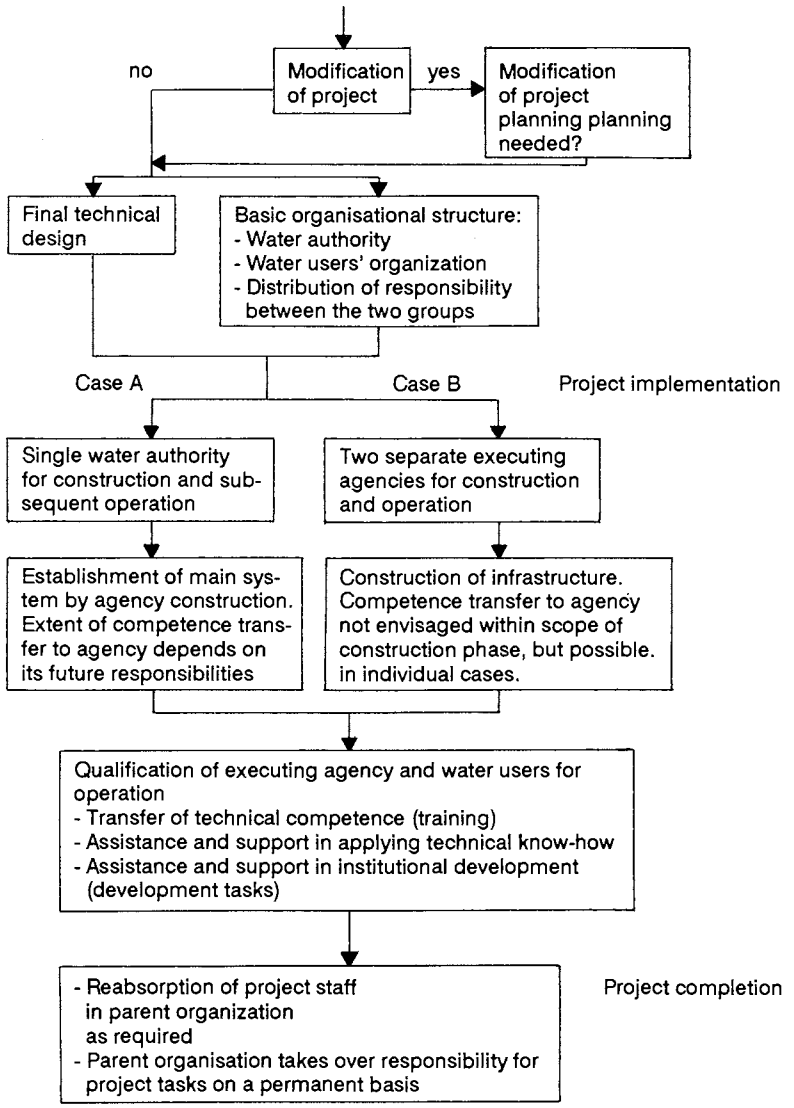
Situation Type 2: Agency-User Projects (AUP)

- AUP's lie in the ranges of medium to high system status (**Overview 2**) and medium management uncertainty (**Overview 3**).
- Management responsibility is divided between a water authority* and the water users*. Sustainability* of the project's impacts is guaranteed by both groups.
- The degree to which management responsibility is divided depends on the respective performance potentials* of the two parties. Experience shows that in many cases water authority management responsibility tends to focus on overall system management, i.e.on the general planning and controlling of the overall system. This includes the management of water acquisition and distribution in the **main canal system.** Water user responsibility tends to be located chiefly in the area of water distribution and utilization at the **field system** level.
- A multi-purpose water authority in the AUP is required to cover an extremely wide and qualitatively heterogeneous **performance spectrum**; the management of the infrastructure demands **technical** solutions and a production-oriented management approach, while the management of the **system of social relationships** is more readily implemented within a service-oriented management approach. Successful system management must attempt to apply both approaches separately within the same system.
- In order to increase the performance capacity of the water authority, the project should transfer competence in the **technical** sector (planning, construction of the hydraulic infrastructure, operation and maintenance of the main canal system) and in the **social** sector (conflict management, support for water users) through gradual experience and learning processes.
- For the water users, the main emphasis of qualification is placed a) on the transfer of **technical know-how** for successful management of autonomously operated technical sub-systems; b) on the transfer of **social and organizational competence** for the formation of user's groups and to enable water users to participate effectively in decision-making processes at the overall management level.
- The processes of competence transfer demand **flexibly** formulated goal, input and time specifications, especially in the organizational and social sector.

- The sequence of phases in AUP's might be roughly as follows: **project identification** (especially analysis of the performance potential of the water authority and the future water users), **water master plans, project planning** (including differentiation of construction tasks (infrastructure) and development tasks (organization), specification of a minimal design), **pilot phase** (covering an area large enough for satisfactory testing of organizational and social processes), **modified project planning, project implementation** (with emphasis on competence transfer), **project completion.**

Overview 6: **Flow Chart - Planning Concept for an Irrigation Project with Divided Management Responsibility (Project Concept 2)**





5.4 Conceptual Aspects of the Management of Irrigation Projects with Open Management Responsibility (Open Irrigation Projects)

5.4.1 Management-Specific Attributes of Open Irrigation Projects

Open irrigation projects represent a response to **Situation Type 3** (**Figure 8**):

- they lie in the range of **low to medium system status** (cf. **Overview 2**);
- the situation is marked by **high management uncertainty** (cf. **Overview 3**).

Development cooperation* practice shows that a desire for assistance in the establishment of irrigation systems* by the partner country must often be expected even in cases where there is **high management uncertainty,** due to

- the fact that governmental organizations or farmers have little or no experience in irrigated agriculture and its management*;
- a generally low level of institutional development in the potential project executing agencies in the partner country, foreshadowing a considerable discrepancy between the management requirements entailed by irrigation and the available management capacity.

In this situation, the sustainability* of project impacts often referred to in these guidelines can be ensured neither by existing organizations nor by the farmers. Usually, neither party possesses the necessary **short or medium term performance potential*** to construct and operate an irrigation system successfully.

It is important for decision-makers in development cooperation to appreciate the **unusually long project time spans** anticipable for projects forced to start out from seriously underdeveloped performance potentials. From a development policy viewpoint,it is therefore advisable to respond to such an irrigation project proposal from the partner country by probing **development cooperation alternatives outside the irrigation sector**. Only if irrigation is the sole or preferred option for development

measures under the given constraints should the implementation of an open irrigation project be considered with the partner.

In order to guard against disappointment in the partner country, the donor organization* should, however, point out the long project durations expected and the need for a **sequential procedure** (**Chapter 5.5.3**). This procedure is aimed at gradual improvement of existing water authority and farmer performance potentials in preparation for **future** irrigation measures. For those responsible for the system in the partner countries, who are under political pressure to show results, this means that over a long period of cooperation there will be few tangible advances to show in the form of, say, a complete hydraulic infrastructure.

The sequential procedure for the development of performance potentials and the validation of their functional adequacy - for example in the form of pilot measures* - allow the project to be terminated in good time if it becomes clear that the necessary performance potentials cannot be developed. In the partner country, a project termination will tend to be perceived negatively. For those responsible for development cooperation it will, however, provide an opportunity to save the investment required for development of a complete physical infrastructure (much higher than costs for the pilot phase) if inadequate performance potentials indicate that the infrastructure would never be fully exploited.

5.4.2 Management Principles of Open Irrigation Projects

A principle which must be observed in designing this type of project is that the **goals** are of a character very different to those of the project types discussed above. Open irrigation projects pursue primarily **organizational development goals**.

> The project goal will have been attained if the performance potentials of the water users and the water authority have been developed to a point at which further project concepts can be implemented successfully. Production or productivity goals are of subordinate importance.

The point of departure for organizational development* is the available local institutional capacity. In the case of farmers with no experience of irrigated agriculture, or with experience under completely different conditions, it is especially hard to determine from their personal and social structures their ability to work successfully within an irrigation system. **This cannot be achieved simply by questioning or calculation.** If there

is no comparable experience in the immediate system environment, the only promising alternative would seem to be the lengthy and arduous task of **imparting actual experience**. This means that selected groups of future water users* must be given the opportunity to gain experience of water use through **pilot measures** (action research*).

In principle, the same considerations apply to the executing agency, i.e. the future water authority. It must also be given the opportunity to familiarize itself with irrigation problems, try out different solutions and, above all, gain experience in working with the water users. In the course of the project, results obtained from this process should then help to answer the question:

> What should be the long-term orientation of the water authority, i.e. should it try to manage the system jointly with the water users (agency-user project) or should its long-term role tend more strongly towards the provision of services for the water users (water user project)?

A fundamental problem in open irrigation projects, affecting both the water authority and the farmers, is that performance-improving measures tend to arouse **expectations** of future irrigation-related development activities. These will, however, materialize only if the open project is successful, that is, if adequate performance potentials can be created. To avoid disappointment, this fact should repeatedly be made clear to the parties in the developing country.

5.4.3 Features of the Planning, Implementation and Operation Phases of Open Irrigation Projects

The following section develops a sequence of phases for open irrigation projects (see **Overview 7**) which may be suited to the specific character of this type of project. The following phases are involved:

a) Project identification,
b) Master plan,
c) Project planning and implementation on the basis of a sequence of concerted pilot measures,
d) Transition phase to the subsequent irrigation project, i.e. modified planning of an irrigation project according to Project Concept 1 (**Chapter 5.2**) or Project Concept 2 (**Chapter 5.3**).

ad a) If the initial **idea** for the implementation of an irrigation project comes from a partner country, it must be assumed that the partner will often have underestimated the specific problems posed by the situational configuration which serves as the point of departure for an open irrigation project. As mentioned in **Chapter 5.5.1**, it is sensible for the responsible persons in the partner country to work with the donor organization in checking the feasibility of alternative development projects **outside the irrigation sector**. If cooperation is to take place in the irrigation field, the donor organization must in particular point out the anticipated **long project durations** and the difficulties involved in institutional development work. This includes developing goal and output criteria **not primarily oriented towards production or productivity considerations**.

Project identification is possible only if there are at least broad notions of the form of future irrigation projects in the region. Knowledge of locally available water resources and technical means of exploiting them are essential. The necessary data are collected as part of the preparation of a master plan (cf. b).

ad b) In many cases, there will be no clear picture of the actual availability of water resources for irrigation purposes in countries with little or no tradition of irrigation. The desire of politicians to set up irrigation projects generally stems less from well-founded knowledge of unused potential and possible methods of exploiting it than from a vague general notion that inadequate national food production could easily and rapidly be increased by irrigated agriculture.

It is therefore the task of the donor organization to ensure that at the beginning of the project, as part of the preparation of a **master plan**, an assessment of **water resources** is established and an analysis of **technical alternatives** for their exploitation in agriculture is carried out. The basis for such work is formed by the 'classic' studies which collect data on the entire climate-soil-water complex in the region under consideration.

The master plan should also note current irrigation activities in the region and analyze their results. It may then be possible to define certain points of departure and indications for the design of the open irrigation project.

Master planning should include pre-feasibility and feasibility studies to provide a broad indication of the infrastructure required for the project. A pre-requisite is, however, that this infrastructure can be divided into

sub-systems capable of being used and tested **in stages** by a water authority and by individual groups of water users.

ad c) In open irrigation projects, it is advisable to treat **project planning and implementation** as one rather than several separate phases, since planning and implementation repeatedly alternate in a series of stages based on packages of measures, each of pilot character, and to some extent based on one another. This sequential procedure should be oriented on progress in the **learning and development process** for the water authority and the water users. Such a procedure demands **flexible planning** of a kind not demanded by any of the other project concepts described here.

In contrast to the conventional philosophy, which sees pilot measures as unique 'test-beds' at the beginning of a project,

> the entire implementation of open irrigation projects consists of measures which have a 'learning character'; their distinguishing feature is that each learning phase is aimed at contributing to the further development of the institutional capacity of the affected groups.

The project planning and implementation phase begins with detailed **planning** of the **first** pilot measure, supplemented by a broad estimate of the time-frame, funding and staffing for the subsequent measures.

Pilot measures which are **implemented** must be continuously monitored and evaluated. The resulting insights contribute to detailed planning of the next measure. The area to be monitored is extremely broad and heterogeneous, ranging from purely technical, readily quantifiable cause-effect relationships, to virtually unquantifiable social relationships between the water authority and the future water users.

Open irrigation projects offer water users and water authorities the opportunity to acquire gradual mutual understanding of the general technical and social problems of irrigation and of the partner's specific problems. This facilitates future cooperation, irrespective of the eventual division of responsibilities between the two parties.

The development of performance potentials through appropriate pilot measures must be oriented on the central problem areas of irrigation systems. These are primarily:

- water acquisition management,
- water distribution management,
- maintenance of the hydraulic infrastructure,
- conflict management,
- organization of the water users,
- extension services for irrigated agriculture,
- resource mobilization.

The number of learning packages required and the necessary resources will depend on the special areas in which problems arise and the success of the learning process within the affected groups.

ad d) If, during the course of an open irrigation project, it becomes apparent that the desired performance potentials of the water authority and the water users are beginning to materialize, a **transitional phase** should consider how the potential created should actually be utilized. If the results of the open irrigation project are considered positive, one obvious course will be for the donor organization to continue cooperation within the framework of a new project.

The cooperation which follows an open irrigation project may in principle take the form of a water user project (cf. **Chapter 5.2**) or a project with divided management responsibility (cf. **Chapter 5.3**). The final decision will depend on the quality of the performance potentials created and the system status at the time when the decision is made.

Even after successful implementation of an open irrigation project, however, it must still be assumed that the performance potentials of both the water users and the water authority will need further consolidation and support for some time.

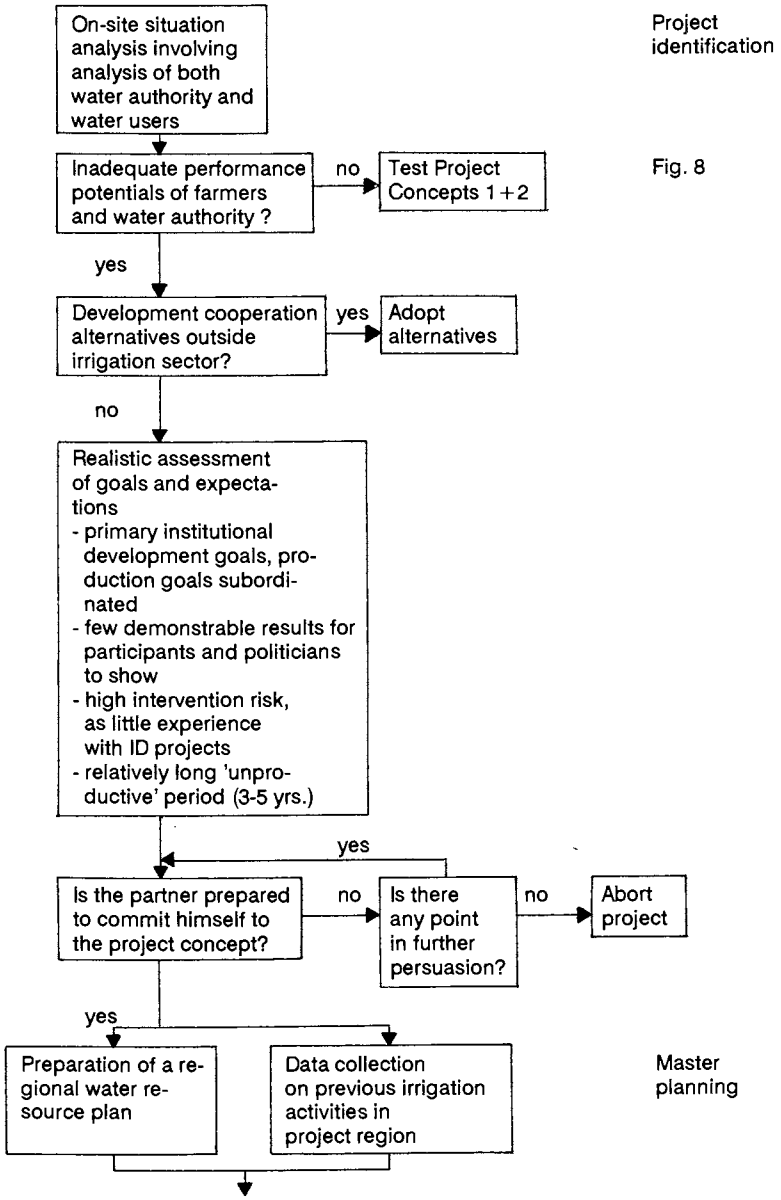
> The follow-on project, at least in its initial phase, should therefore lie as far as possible in the region of **low system status (Overview 2)**, especially in terms of the number of operational levels* and the overall irrigated area.

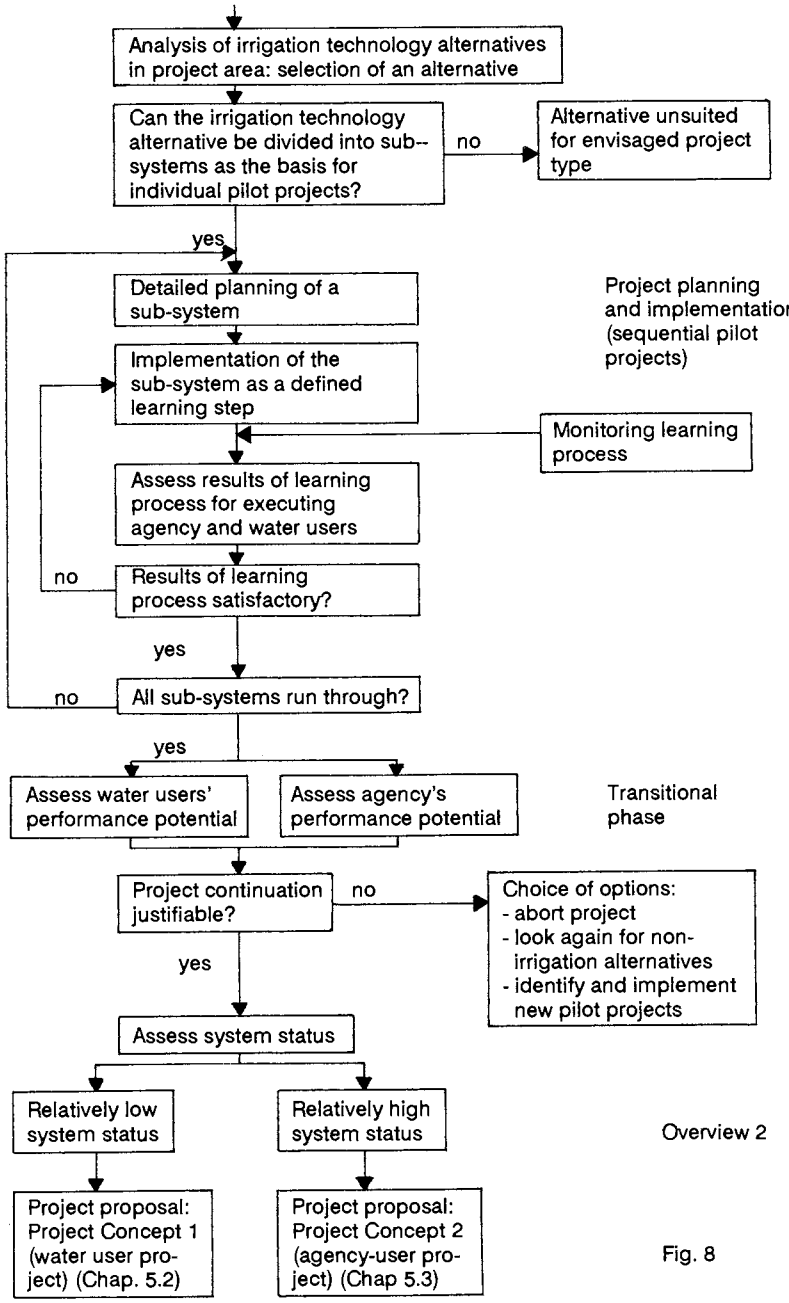
Summary Chapter 5.4 (terms marked with an asterisk are defined in the glossary).

Situation Type 3: Irrigation Projects with Open Management Responsibility (IOMR's)

- IOMR's are in the range of **low to medium system status** (**Overview 2**) and **high management uncertainty** (**Overview 3**)
- In IOMR's, both water users and government agencies have little or no experience of irrigated agriculture and irrigation management questions.
- Neither group therefore possesses the necessary **short-or medium-term performance potential*** to set up and operate an irrigation project successfully.
- IOMR's pursue primarily **institutional development*** goals. The principal goal of IOMR's is thus not to create a hydraulic infrastructure or to stimulate a short-term growth in agricultural production, but to develop functional organizations and their performance potentials.
- The development of organizations and performance potentials is an area in which little or no development cooperation experience has existed, until recently. A time-consuming learning* process involving the donor, water authority and water users' organization should therefore be allowed for.
- This process should take place step-by-step, in the form of a **concerted package of measures** (**sequential procedure**). This gives water users* and the prospective water authority* the opportunity to familiarize themselves with irrigation problems in the actual work situation and to test common solutions.
- During the implementation of these individual steps, the long-term **division of management responsibility** between the water users and the water authority can be assessed on the basis of the performance potentials actually developed, i.e. the party that should logically assume a particular management responsibility can be determined.
- This assessment indicates whether the general trend of further development of an IOMR should be along the lines of **Project Concept 1** (water user project) or **Project Concept 2** (agency-user project).
- The following project phases take account of the special demands of an IOMR: project identification, master planning, project planning and implementation as a reciprocal process on the basis of sequential, coordinated **pilot measures**, and planning of the transition phase to Project Concept 1 or 2 (cf. **Chapter 5.2** or **5.3**).

Overview 7: **Flow Chart - Planning Concept for an Irrigation Project with Open Management Responsibility (Project Concept 3)**





5.5 Conceptual Aspects of the Management of Technical Irrigation Projects

5.5.1 Management-Specific Attributes of Technical Irrigation Projects

Technical irrigation projects represent a response to **Situation Type 4** (**Figure 8**):

- they lie in the range of **medium to high system status**,
- they have **low management uncertainty** (cf. **Overview 3**).

The goal of technical irrigation projects is to assist the management of an irrigation system* in the construction of **material** or **physical components** of the system. In practice, this usually involves civil engineering works on the hydraulic infrastructure, such as the construction of an intake weir or pumping plant. Other system components may, however, be involved, such as the provision and establishment of a computer system for irrigation control. The fundamental principle is always that

> the contribution of the donor organization* is confined to the **establishment of physical system components or technical services**, which are then operated by the water authority without further external assistance. Consultancy services and competence transfer by the donor agency are not planned or are envisaged only to a limited extent.

As indicated in **Figure 8**, the situational configuration on which such projects are based forms a relatively closely-defined field at the **bottom** end of the **intervention line*** (**low management uncertainty**). The intervention line in the lower half of the matrix was determined in **Chapter 4** on the basis of the estimated **need of the developing countries for external contributions** (**Figure 3**) and the development policy relevance of measures in this field (**Figure 5**). An estimate based on these two criteria indicated only a **low** priority for intervention in the bottom zone of the matrix.

In **Figure 4**, by contrast, it was established that this area should be regarded as a **potential focus for financial (investment) measures** (matrix fields H and I). The justification was to be found in a consideration of intervention **risk**; there are well-developed performance potentials* on the water authority side in the area of low management uncertainty. Financial contributions by the donor organizations* can therefore be competently administered and utilized by the water authority, and the risk of misplaced investment is relatively slight.

Referring to **Figures 7** and **8**, technical irrigation projects may be defined and characterized as follows:

- their 'lower' boundary (decreasing management uncertainty) forms a **fluid transition** to the situation zone in which mainly **financial** contributions are required, but not advisory services in the management field ;
- their 'upper' boundary (increasing management uncertainty) possesses a **fluid transition** to the situation zone covered by agency-user projects, i.e. projects with divided management responsibility. In this zone, there is an equal requirement of financial contributions **and** consultancy, and **close coordination** between the two is essential (cf. **Figure 4**).
- since technical irrigation projects are located in the range of medium to high system status, management responsibility will be divided, as in agency-user projects (cf. **Chapter 5.3**). As the **water authorities** in most cases will assume responsibility for overall system management, it is they who will demand external contributions to the provision of hardware or services.

In view of the development cooperation requirement for sustainability of project impacts, it may be concluded that technical irrigation projects can be implemented successfully only where

> the water authority possesses the **performance potential** to utilize the components provided **in conformity with the demands of the system without further outside support**. This ability decreases with growing management uncertainty. Isolated external contributions may then have a dysfunctional impact on the system.

The narrow definition of the intervention zone for technical irrigation projects in the present guidelines (**Situation Type 4** in **Figure 8**) **conflicts with customary practice** in the development cooperation field. Isolated technical irrigation projects are currently being implemented in a

development cooperation context over a wide range within the matrix, i.e. even in the zones of medium to high management uncertainty. This results from inadequate appraisal of performance potential and over-optimistic assessment of the performance potential of the water authorities concerned.

Previous results strongly suggest that isolated provision of technical system components or services by donors leads to **long-term** success in only a relatively small number of cases. In most instances, it is both necessary and advisable to couple the introduction of technical irrigation components with appropriate measures aimed at strengthening the water authority involved. Intervention then tends to fall more in the range of **Project Concept 2**.

5.5.2 Management Principles of Technical Irrigation Projects

In order to ensure that intervention within the framework of **Project Concept 4** is really advisable, the donor organization must first assess the performance potential of the water authority by means of an intensive **agency analysis**. It should be noted that **two different agencies** may be involved, an executing agency for the planning and implementation of the project and a water authority for the long-term utilization of the newly-provided physical components. In such a case, **both** agencies may need to be analyzed to determine their **specific** capacities for planning and implementation or tasks connected with the long-term operation of the system.

Agency analyses are often carried out in practice, but the analytical tools available are generally capable of improvement. It is also unlikely that the recipient side will readily accept the need for such analysis in this type of situational configuration, where it is assumed that a purely 'technical' contribution is being made to a competent water authority. The donor organization must therefore explain to local representatives that identification of an apparently purely 'technical' project must be confirmed by a second analysis conducted from an 'institutional' viewpoint.

From a management standpoint, the establishment of isolated physical components should be organized in the form of a **project*** in the **industrial management** sense:

- On the input side, the quantity and quality of inputs, i.e. material and financial resources, can be determined relatively precisely, allowing detailed procurement planning.

- The predominantly technical character of the measures allows both the methods employed and the results achieved to be operationalized with relative ease, yielding reliable planning indicators.

- At least some cause-effect relationships exist between inputs and outputs, encouraging realistic assumptions.

- The comparatively limited need for intensive coordination with the water users reduces the complexity of the planning process.

Unlike the project concepts presented in preceding chapters, technical irrigation projects **at first sight** appear to have relatively little impact on the water users*. The water authority assumes that measures take place directly under its own responsibility, and that coordination with the farmers in the sense of **participatory planning** is either unnecessary or infeasible in the medium term. This substantially reduces the complexity of the task from the viewpoint of the water authority.

The donor organization, with an eye on development policy objectives, may see the situation from a rather different angle. The technology employed in a project will inevitably influence decision-making options and the behaviour of the water users. The donor organization should therefore utilize its role as a partner in irrigation system management to point out these interrelationships and help to analyze them.

A considerable success will already have been scored if the water users are informed of all steps taken by the water authority, and if their viewpoint has been expressed and listened to on all items where the planned design of the project might be expected to force **changes in their future behaviour patterns**. The latter can be ensured by running a parallel **impact analysis** throughout the planning and implementation period.

5.5.3 Attributes of the Planning, Implementation and Operation Phases of Technical Irrigation Projects

In contrast to the project concepts outlined above, technical irrigation projects demand no fundamental modification of the development cooperation project sequence.

One factor of decisive importance for successful implementation of this type of project will be the analysis of the water authority referred to in **Chapter 5.5.2**. Analysis of the real situation all too often reveals that, given external assistance, water authorities can indeed establish a

desired physical component, but cannot then make satisfactory use of it. In addition, little is often known about the **impacts** the introduction of such components have on the **water users**.

With an eye to water authority capacity and water user impacts, guiding principles for the design of technical irrigation project measures should therefore take account of the following issues :

- In the project **identification phase**, there should be an agreement between the recipient and donor agencies, that an **agency analysis** may be carried out, if there are justified doubts as to the performance potential of the water authority. An additional **impact analysis** must be performed in all cases. Participation of water authority staff in both analyses must be ensured. The water users should be involved as far as possible in the impact analysis. Neither analysis should ever be carried out solely by representatives of the donor organization.

- The agency analysis of the water authority must form part of **preparatory project studies**. It should be dealt with according to its true importance, and not merely dismissed with a few sub-paragraphs and an often unrealistic organizational diagram of the agency.

- The results of preparatory (technical) studies and the agency analysis must be carefully **correlated** before detailed planning or actual implementation is undertaken.

- The water authority analysis must be carefully assessed and evaluated. If the agency's capacity is regarded as insufficient for successful use of the planned new system component, a switch to a project with **divided responsibility** (**Project Type 2**) should be considered.

- Such a 'switch' to a different type of project can be carried out at this (or at a later) stage only if the tools and methods available in **financial and technical cooperation fields of cooperation** are properly coordinated.

- Analysis of the agency's performance potential should not be restricted to a single study at the beginning of the project. Weak spots in the agency's organization may be revealed during the course of implementation, i.e. during joint construction or establishment of the physical system components. The agency analysis should therefore be seen as a process which accompanies the entire project.

- The technical design of the physical system components proposed in the feasibility study should provide the point of departure for **initial analysis of the potential impacts** of these components on the water users.

- Like the agency analysis, the **impact analysis** should be designed to continue throughout the process, so that dysfunctional impacts on the water users can be detected and analyzed during all phases of the project. The particular benefits of this analysis are the insights it yields into new problems the project is likely to create for the water users. In such cases, measures to help the water users find a solution should be initiated in the accompanying implementation phase.

Summary Chapter 5.5 (terms marked with an asterisk are defined in the glossary).

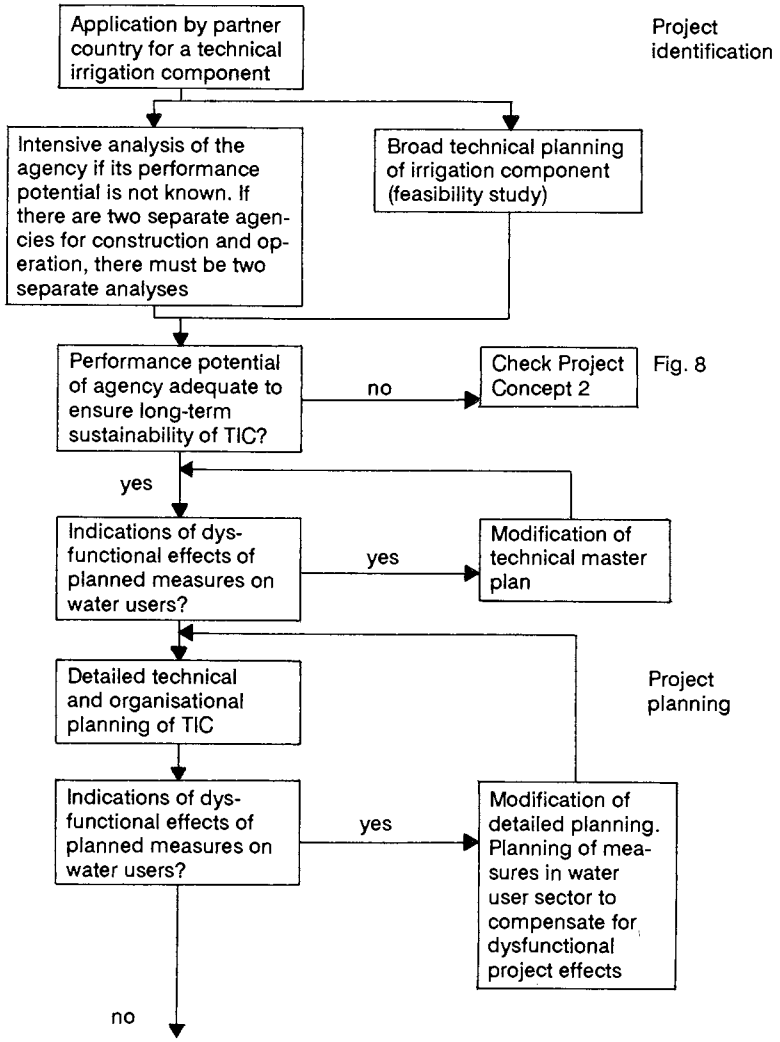
Situation Type 4: Technical Irrigation Projects

- Technical irrigation projects lie in the range of **medium to high system status** (**Overview 2**) and have **low management uncertainty** (**Overview 3**).
- The low management uncertainty is expressed primarily in the high performance potential* of the existing water authorities*. Technical irrigation projects are thus located at the bottom end of the intervention line*, in a promising zone for **financial/investment** contributions by the donor organization* (**Figure 4**).
- The medium to high system status indicates that management responsibility in technical irrigation projects is divided between an water authority and the water users*. In practice, however, external contributions that correspond to the technical irrigation project type will generally be applied for by the **water authority**, which will be responsible for overall irrigation system* management in most cases.
- The goal of a technical irrigation project is to support the management* of irrigation systems in the construction or establishment of physical system components.
- The contributions of external donor organizations are confined to the provision of physical system components. Advisory services and competence transfer are required either on a limited scale or not at all.
- From a sustainability point of view, technical irrigation projects are advisable only if the local water authority has the necessary perform-

ance potential for **long-term system-adapted** exploitation of the infrastructure. If the potential of the agency is not sufficiently well known, a detailed agency analysis* is essential.

- Where there are two separate agencies - a project executing agency for the planning and implementation of infrastructure construction and a water authority for long-term operation of the system - both agencies should be analyzed.
- Technical irrigationn projects can be managed as projects in the industrial sense; owing to their technical character, the resources used, methods employed and results achieved, they are relatively operationalizable and plannable. The potential and need for water user participation are relatively limited where new components are restricted to parts of the system destined to be run even in the long term by the water authority.
- Technical irrigation projects should supplement the agency analysis of the water authority by an **impact analysis**. This should clarify the potential (identification phase) or actual impacts (implementation phase) of the planned measures on the **water users** . If impacts are identified, planning must be modified or appropriate accompanying measures introduced to help the water users solve the newly-created problems.
- In existing development cooperation*, isolated technical irrigation projects are located throughout the matrix, i.e. even in areas with high management uncertainty. In these guidelines, the zone for successful intervention in the form of technical irrigation projects is very narrow, since experience shows that the required performance potentials are relatively rare in developing countries. Technical irrigation measures should therefore more frequently be associated with advisory and training contributions. In such a case, a switch to **Project Concept 2** should be considered.

Overview 8: **Flow Chart -Planning Concept for a Technical Irrigation Component Project (Project Concept 4)**



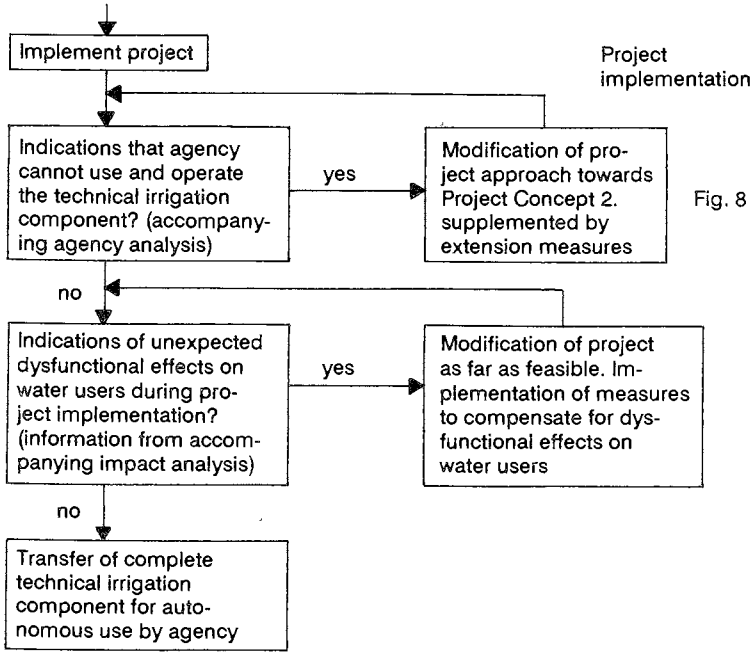


Fig. 8

6. Concluding Remarks

The hopes pinned by the governments of developing countries on irrigated agriculture have in the past often been disappointed. There is a growing recognition among specialists in developing countries and donor organizations that the lack of success of irrigation projects stems not only from technical deficiencies, but also from unsatisfactory irrigation system management.

Recognition on its own is not enough. All groups concerned should try to remedy the deficits in irrigation management as rapidly as possible. The development of a **situation-adapted management concept** of the type presented in these guidelines for German development cooperation is only the first step. In view of the number and variety of open questions in the management field, intensive discussion of the basic concept and its situation-specific features is necessary in order to create the vital tools for **operational system management**.

This discussion is intended to result in a set of working aids for operational irrigation system management, enabling the present concept to be implemented effectively within the irrigation system management context.

Attempts to put the concept into practice should preferably begin in those projects and countries where a basic consensus on the concept can be achieved with the decision-makers responsible.

In this context, it should not be forgotten that the concept presented here inevitably imposes a series of demands on **those responsible** for the planning, implementation and operation of irrigation systems. These demands equally affect members of the local water authorities, water users and seconded specialists. Future technical cooperation is thus faced with a qualitatively new and difficult task in the training sector.

From a development policy point of view, it is important to note that the irrigation system management concept presented here relates to only one area of third world rural development, and can become fully effective only once it has been integrated in the overall rural development concept.

Glossary

Action research: A research approach directed not at forming a theory but at direct and rapid implementation of results. Action research is conducted in close cooperation with those affected (water users, representatives of the water authorities). Implementation takes place in stages, in which feedback permits iterative → learning and continual revision of measures (→ process, → rapid rural appraisal).

Agency analysis: Analysis designed to provide information on the → organization and → performance potential of an → executing agency/water authority.

Complexity: The intricacy of interrelationships between the elements of a system and its Ä system environment. Complexity sets limits to the intellectual comprehension and control of systems.

Conflict: Behaviour of individuals or groups which recognizably contradicts that of other individuals or groups within a social system.

Contingency approach: Contingency approaches in management theory assume that in management the means of achieving certain ends will vary with varying situational sets. If particular situations prevail, then certain management measures will contribute to achieving certain ends (if-then approach).

Contingency factors: Conditions governing a situation which management needs to allow for in designing and controlling a → system.

Dependence (of a system on its → system environment): Those interrelationships of a system with its system environment which necessarily affect the decisions and actions of system management. The degree of dependence is expressed by the scope and intensity of these interrelationships.

Development cooperation: Provision of staff, material and financial contributions by → donor organizations with the aim of supporting a partner country in initiating and maintaining a long-term, sustainable, autonomous development process.

Divided management responsibility: Exists where neither the water users nor the water authority(-ies) is able or willing to assume sole management responsibility for an irrigation system.

Donor organization: Organization which supports partner countries of the third world within the framework of → development cooperation. From a management viewpoint, this results in → management cooperation between the donor organization, the → executing agency and the → water users.

Dynamics: Frequency of changes within a system over time. High dynamics mean a high rate of change. The dynamics of a system are governed by the extent to which it is → open and by its non-static environment.

Element: The smallest unit of a system, which cannot or should not be further sub-divided.

Environment: Synonymous with the ecological → system environment. Comprises natural phenomena such as climate, soil conditions and availability of water.

Environmental compatibility: State in which an → irrigation system is integrated in the → environment in such a way that neither undesired effects of the system on the environment nor significant restrictions on the attainment of system goals due to environmental factors will occur.

Executing agency: The legal entity in the partner country responsible for the implementation of the project in staffing, financial and technical respects. In irrigation projects this will generally be a (para)-state irrigation body (irrigation agency, water authority) and rarely a private entity.

Goal quality: Criteria of goal quality are operationality (goal content, goal level, temporal determination), goal consistency (means-ends relationships) and realism (real versus formal goals).

Goal-orientation: The → management of → irrigation systems must be aware of the objectives and interests of the → target groups and influential → interest groups in the → system environment. It must evolve strategies suited to optimum achievement of these goals.

Institutional development: Strengthening the capacity and → performance potential of an institution such as a water authority or a water users' association to carry out its mission and perform its management functions more effectively on a sustainable basis.

Interaction: A situation is interactive if many of its elements are interrelated with other elements, each variable influencing and being influenced by many others.

Interest groups: Individuals or groups with an interest in the expected or attained results of a project as a result of their specific goal structure. In order to minimize → conflicts, interest groups must as far as possible be taken into consideration by those responsible for management.

Intervention line: Line delimiting those situational configurations which may be regarded as especially promising for → development cooperation from a management point of view. Interventions by the donor should as far as possible be restricted to situations inside the intervention line.

Irrigation agency: see Water Authority

Irrigation system: System in which specific groups of people endeavour in an organized manner at a defined location and in an interactive relationship with the system environment to produce irrigation-specific products and services which may be judged as positive contributions to the attainment of goals aimed at by the members of the system and external interest groups.

Irrigation tradition: Indigenous knowledge and experience of individuals and groups of persons regarding the techniques, organization and socio-economic conditions of irrigation, gained through active participation in irrigation systems over a longer period (generations).

Learning: Iterative improvement of the behaviour of people and systems through the acquisition of new, permanent problem-solving features.

Management: In the **functional** sense, management is the process of designing and controlling → goal-oriented → socio-technical systems in conformity with the situation. "Design" includes those human activities directed at creating a socio-technical system and maintaining its long-term viability. "Control" is the process of guiding a system in such a way that it assumes a desired state. In the **institutional** sense, management

is a sub-system of the → organization with authority and responsibility for performing → management functions.

Management concept: Theoretical concept for the design of → management in conformity with a → situation (e.g. for an irrigation system).

Management cooperation: Joint performance and coordination of management functions in a development project between the local project management and external specialists.

Management function: Group of tasks which it is fundamentally necessary for → management to carry out in order to design and control the system effectively. Basic management functions are planning, organizing, controlling and leading.

Management Uncertainty: A wide array of →contingency factors with varying weight and various degrees of predictability causes uncertainty for management in performing basic management functions (planning, organizing, leading, and controlling).

Non-profit organization: Organization not (exclusively) subject to the economic dictate of yielding a profit and therefore differing in its objectives, tasks and structure from a profit-making organization. In non-profit organizations, the primary objective is that of providing for needs rather than a system of formal goals (profit, profitability). → Services often play a decisive role in the non-profit organization's activities.

Openness (open system): An open → system exchanges material, energy and information with its → system environment. An open system is therefore subject to external influences or it is capable of altering its system environment by means of appropriate management (→ dependence).

Operational level: Physically-determined sub-section of a water distribution system located between water source and fields and demarcated by water control points. The greater the number of operational levels in a system, the higher the demands on system management.

Operational management: Performance of management functions in specific **sub-systems** of an organization, allowing for anticipated short-term changes in the → system environment (→ strategic management).

Organization: In the **institutional** sense: goal-oriented social structure with a definable membership. This structure serves as a framework within which → management as an institution performs its → management functions. In the **functional** sense, organization (organizing) is one of the four → management functions.

Participation: Collaboration of individuals/groups in decision-making processes through information, advice or joint decisions. In line with the → contingency approach, the degree of participation depends on the concrete → situation. The objective is thus **optimum** rather than maximum participation.

Performance potential: The potential of persons, groups or institutions for providing material, financial, physical or creative resources either for their own development (→ organizational development) or for third parties.

Pilot measure: A trial or model scheme permitting the participants to gain insights into fundamental processes and interrelationships in irrigation schemes with reduced risk and input.

Process: Flexible sequence of steps and procedures which in each case correspond to the development of the → system at a certain point in time and which permit iterative → learning from previous steps by means of feedback mechanisms (→ action research).

Project concept: Theoretical model for the realization of a → project and for the definition of the ways, means and methods to be used for project realization.

Project phase: Temporally and logically coherent section of a project. The sum of all project phases constitutes the overall duration of the → project.

Project: A package of measures typified by its uniqueness and by time, space and budget limitations in regard to a defined objective.

Qualification: Defined here as providing institutions, groups or individuals with the necessary competence to assume a certain responsibility or play a certain role in the management of irrigation systems

Rapid rural appraisal: Fast exploratory field research conducted by small multidisciplinary teams on the basis of unstructured interviews. Rapid rural appraisal is methodically open (method mix) and is frequently employed in conjunction with → action research.

Sequential procedure: A procedure consisting of a series of steps with feedback effects between individual stages (→ process, → action research).

Service: Unlike the industrial production of goods, the provision of services primarily relies on social interaction between the provider and the client. Interaction-oriented services are largely inaccessible to industrial management and demand their own specific management approaches.

Situation: Sum of the real factor mixes (→ contingency factors) present in the system environment and within the system (system-internal factors) at a given time.

Socio-technical system: In the social sciences, this term denotes a → system in which human beings as decision-makers and actors are of primary importance, although the coordinated interaction of social and technical components of the system is also stressed.

Strategic management: Development and implementation of a long-term → management concept, related to the → system **as a whole** and intended to enable it to react in a flexible, goal-oriented way to future changes in its → system environment (→ operational management).

Sustainability (of project effects): The physical and institutional structures created by project measures are autonomously maintained and used by local personnel after completion of the project in such a way as to achieve long-term realization of the desired conditions or changes.

System conservation: Long-term stable development of a system along planned lines of development.

System Design: In the sense of → management as defined in these guidelines, system design is defined as those human activities aimed at creating → socio-technical system and sustaining its long-term viability. (Note : this definition embodies the traditional engineering understanding of design, which is basically restricted to physical infrastructure.)

System environment: A distinction is drawn between the general and the specific system environments. The **general** system environment (constraints) includes everything external to the system which may potentially influence the system or be influenced by it. The **specific** system environment comprises only those components of the system environment directly affecting the attainment of the system's goals or directly influenced by the system's impacts.

System status: The totality of all → contingency factors except for → system environment and → performance potential, both of which correspond to → management uncertainty. System status considerably influences the distribution of management responsibility between → water authority and → water users.

System: Totality of elements interconnected through structures and relationships. A system can be divided into sub-systems capable of being regarded as relatively autonomous units (→ open (systems), → complexity, → dynamics).

Systems theory: Science of the design and classification of → systems.

Target group: Group of persons in the partner country at whom the measures contained in a project are directed and who are intended to profit directly or indirectly from it- So far as the → situation permits, the target group should itself take part in the identification, planning and implementation of the project (optimum → participation).

Water Authority: A local state or para-state institution/agency responsible for the management of → irrigation systems. In most cases management responsibility is divided between the water authority and the → water user (→ divided management responsibility).

Water users: Farmers engaged in irrigated agriculture within an irrigation system. Water users are the final consumers of water. Where they do not operate the system autonomously, they share divided management responsibility with an → executing agency such as a → water authority or irrigation agency.

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