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Governing Maintenance Provision in Irrigation

A Guide to Institutionally Viable Maintenance Strategies

IWMI International Water Management Institute

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in Irrigation

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to Ian Carruthers †

Preface

This Guide is about maintenance in irrigation. However it is *not* about how to *do* maintenance. It is about how to *provide* maintenance. Manuals and guides about how to *do* maintenance abound. In fact, one may assume that "How to" manuals on maintenance written in various languages outnumber any other kind of guide and manual in irrigation. In contrast to this abundance there is – to the knowledge of the authors – not a single guide on maintenance *provision.*

The reader may ask: what in fact is the difference? In this Guide we perceive maintenance not only as a technical activity but at the same time as a *service delivery* by somebody to somebody, in other words, as a *provision*. This may be difficult to comprehend at first sight. However, Ostrom et al. (1993) observe that it may become clearer when we remind ourselves of our daily economic exchanges. Here, we distinguish clearly between goods and services we *produce* ourselves in the household and others which are *provided* to us. This comes down to a distinction between *production* and *provision*. Confusion and misunderstandings are created by the fact that this distinction between production and provision becomes less selfevident in the public and non-commercial realm. Sometimes, the unit of government that provides a facility or a service is also the producer of that very facility or service. However, frequently, a public agency may construct a facility, but rely on private agents to provide services like operation and/or maintenance of that facility. Or else, the agency may contract out all of these tasks.

In this Guide, we contend that major problems of maintenance – not only in irrigation – are due to the fact that maintenance *provision* is deficient or non-functional. Roles, rights and obligations between the providers and the beneficiaries of maintenance are unclear, agreements between these two sides are vague or non-existent, and mechanisms to enforce existing agreements are absent, as are the means to ensure the timely provision of necessary supporting services. In other words: deficient *institutional arrangements* for maintenance provision are – to our opinion – at the roots of the maintenance crisis in irrigation and they are a "blank spot" in the maintenance discussion at the same time.

This is why this Guide promotes a *"provision perspective"* to maintenance that is urgently needed in order to complement the necessary but not sufficient *"production perspective"* that has dominated the maintenance discussion so far.

Having defined the focus of the Guide, it becomes clear that this is *not* a manual for engineers and technicians to help them improve maintenance activities as they are implemented in the field. The Guide hopes instead to help *policy makers, managers, planners and representatives of all the major stakeholders* to develop a new perception of those "soft" institutional problems that need to be overcome when maintenance efforts are to be successful.

The *provision perspective* presented here can be applied well beyond the subject of irrigation maintenance. The concept and instruments of this Guide can be used just as well for any other service provision in irrigation – from water delivery to drainage to supporting services such as input supply, extension or data provision. Moreover, they are valid for fields of service provision other than irrigation.

The Guide builds on the experiences and results of the MAINTAIN project, implemented by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) and financed by the German Ministry for Economic Cooperation and Development (BMZ).

The concept and the recommendations are the result of a number of case studies and thematic papers that have been elaborated by various authors in the context of the MAINTAIN project of GTZ. These MAINTAIN papers are listed in the section on references and literature at the end of the volume. The ideal way to profit from this Guide is therefore to use it in conjunction with these documents, and the Guide contains numerous references to these publications. The Guide, however, is comprehensive and self-contained and can also be used independently.

Acknowledgements

This Guide and the series of Case Studies and Thematic Papers it is based on, are the outcome of the "MAINTAIN project" implemented by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). The project was funded by the German Ministry for Economic Cooperation and Development (BMZ). Without the continuous support of Dr. Hans-Joachim de Haas and his division these results could not have been achieved.

As far as the concept of maintenance provision is concerned, we owe much to two prominent authors and their works: Firstly to Philipp Herder-Dorneich whose publications have spurred much of the discussion on the side of the German contributors to MAINTAIN. Unfortunately, his book "Theorie der Sozialen Steuerung" ("Theory of Social Governance") is only available in German language. Secondly to Elinor Ostrom and her numerous publications on irrigation institutions. The book "Institutional Incentives and Sustainable Development" published by her together with Larry Schroeder and Susan Wynne has provided essential foundations to the concepts and arguments of MAINTAIN.

Particular thanks are due to those members of the MAINTAIN team whose contributions have only been temporary but nonetheless essential: Artur Vallentin, Thomas Buhl-Böhnert, Heike Kühlwein-Neuhoff, Susanne Arlinghaus and Christian Hagen.

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The MAINTAIN papers and this Guide would not have seen the light in their present form without the assistance and the scrupulous editing work of Monica de Gregorio and Oliver Adam.

The authors accept sole responsibility for the content of this Guide.

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Summary and Introduction

The figures are shocking: According to UNEP, some 1.5 million hectares of irrigated land are lost every year as a result of salinisation and waterlogging. The FAO estimates that, world-wide, approximately 30 million hectares of irrigated land are severely damaged, and a further 60-80 million hectares partially damaged. Various studies emphasise the fact that the underlying reasons for this are to be found in the *operation and maintenance (O&M)* of irrigation systems. As the World Bank puts it in its "Review of World Bank Experience in Irrigation", *"Poor quality of project design and planning are big problems, but poor operation and maintenance is a bigger one"… "O&M problems can be seen in the Bank's financing of so many rehabilitation projects. Almost all of them, when scrutinised, turn out to be deferred maintenance projects".*

In an analysis of its experiences in 614 irrigation projects, the World Bank found that 43% of all project evaluations made no reference at all to operation and maintenance issues. The situation is even worse when maintenance is considered in isolation. In the few statistical studies which do exist, operation and maintenance are rarely dealt with separately. Generally the bulk of attention is paid to operational deficiencies and only in exceptional cases do irrigation project evaluations address maintenance issues in any greater depth. The aforementioned World Bank analysis describes the situation laconically: *"… audits rarely pay much attention to poor maintenance"*.

Given this situation, one can only conclude that irrigation faces a *"Maintenance Paradox".* On the one hand poor maintenance is clearly the origin of many of the most serious problems faced by the irrigation sector. On the other hand, maintenance seems to be a sort of "non-issue". What are the reasons for this paradox, this striking discrepancy between the acknowledged importance of maintenance and the lack of attention it is given in irrigation practice?

In this Guide we contend that a one-sided perception of maintenance is the major obstacle that must be overcome in order to devise solutions to this paradox. The maintenance discussion still concentrates nearly exclusively on questions of "how to do"

maintenance and how to finance the needed activities. This *"production perspective"* normally is not concerned with the involved actors, their interactions, and the laws, rules, rights and formal or informal contracts that govern the relationships between these actors. In other words: the existing and the necessary institutional conditions for maintenance provision are not a subject of consideration. No wonder then, that major obstacles to coordination and motivation of the stakeholders in irrigation maintenance can neither be detected nor overcome.

This is why we are not concerned here with the way maintenance activities are implemented, i.e. with the way maintenance is "produced". This is the topic of myriad technical and managerial books and manuals. Instead, our concern here is with the question who makes this "maintenance product" available to whom, how this provision is organized, and the incentives for its provision.

By the same token, the Guide is ***not*** concerned with narrow economic and financial issues of water pricing and tariff setting in irrigation. These issues, important as they are, are dealt with at length in numerous books and articles. However, the Guide does confront the often neglected problem of *finance provision*, i.e. the source of the financing and the terms and conditions which govern its supply. Financing is viewed as part of a service exchange, where it constitutes the "return" for a service that has been or is to be provided. The institutional arrangements required to make that part of the exchange relationship function are at the center of our interest.

In sum, the Guide intends to aid *policy makers, managers, planners and representatives of all the major stakeholders* to develop an understanding of the *"provision perspective"* to maintenance (and to other services) in irrigation and of the institutional issues involved. Given this focus and target group, it is evident that we cannot present recipes. Individual contexts and maintenance problem situations are extremly diverse and subject to many contingencies. Hence there cannot be "cook book recommendations" for how to cope with institutional deficiencies. However, the Guide does present different basic strategies for the improvement of maintenance provision in different institutional contexts. In doing this, we reject the implicit assumption of

technically-oriented maintenance approaches that there is "one best way" to organize maintenance provision. Based on these "situation specific" strategies, a number of concepts and practical instruments can be applied that are presented and discussed in a way that allows their flexible and independent use.

The Guide tries to strike a balance between a theoretical concept paper and a practical manual.

In *Part One*, after briefly taking stock of the maintenance problem in irrigation (Chapter 1), we present a concept that explains the essentials of the perception of maintenance as a provision (Chapter 2). We define *"infrastructure services"* in irrigation and determine the meaning of maintenance provision in relation to such services. We explain the importance of a *performance orientation* for maintenance provision and present some definitions of maintenance that underline this importance. After discussing some *inherent problems of maintenance provision* we expose a perception of water delivery and maintenance as *multi-actor service systems*. Such a way of thinking implies that water delivery and maintenance will only function effectively and efficiently if the *relationships* between the various actors are well-functioning. This requires good *coordination* but at the same time sufficient *motivation* of the involved actors. Considerations like these direct attention to the institutional requirements for service provision (Chapter 3). We concentrate on two dimensions that have to be dealt with in any attempt to develop or improve institutional arrangements: the *institutional framework* and the *institutional arrangements for a particular service provision*, in other words, the "*service arrangement*". Based on these two dimensions we present a methodology – "*Strategic Institutional Positioning*" – that allows differentiating strategies for maintenance provision in different institutional contexts (Chapter 4). Finally, a rough sequence of steps is proposed that may guide efforts to analyse and improve service arrangements for maintenance provision.

Part Two of the book makes available to the reader a range of ten practical *Modules*. These Modules elaborate more in detail each of the steps proposed before. Thus, they touch upon topics like *objective setting for maintenance provision*, they present methods for *rapid asset appraisal* and *rapid assessment of economic incentives for maintenance* and they deal in detail with

various topics relevant when analysing and improving institutional arrangements for maintenance. Among these, the discussions on the issue of *"governance" of maintenance provision* are of central importance. Modules on *"institutional arrangements for maintenance financing"* and *on "actor specific incentive profiles"* conclude the volume.

The Guide is based on and complemented by a series of MAINTAIN Case Studies and Thematic Papers. The reader who is looking for detailed references and literature should consult these documents. When using the Modules in the second part of this book, indication is given as to the MAINTAIN Papers that are most helpful to consult additionally.

However, even on its own, the Guide can be used in the following ways:

- The Guide may be used as an introductory text on the *"provision perspective"* to maintenance;
- it may be used as a guide to design situation specific maintenance strategies for irrigation maintenance;
- it may be used in a flexible way to provide particular instruments that help cope with specific problems of maintenance provision.

Part One

From Maintenance “Production” to Maintenance “Provision”

1. The Maintenance Problem

The United Nations predicts that the world's population will increase by about 3 billion between 2000 and 2050. The FAO has argued that 60 % of the additional food required by this growing population will have to be produced on irrigated land. In many countries the yields for food crops have leveled off over the past decade. Moreover the amount of good new land which can be devoted to growing crops is extremely limited. However, there remains considerable potential to improve the yield of food crops per unit of irrigation water delivered. Hence, much of the increase in food production in the future will need to come from improvements in the operation and maintenance of existing irrigation systems.

Despite this powerful need to improve irrigation management, the performance of irrigation systems has, in general, been disappointing (especially those in the public sector). Large sums have been spent for construction, rehabilitation and modernization, while comparatively small amounts have been spent for operations and maintenance. Maintenance tends to be deferred to the future, in anticipation of external financing for rehabilitation. Deterioration of public irrigation systems in developing countries is rapid and almost universal, resulting in loss of production and frequent rehabilitation.

A World Bank study found that approximately 66 % of funds invested annually for irrigation development are for "premature rehabilitation", which was made necessary by deferred maintenance. In many developing countries with over-staffed bureaucracies, the large majority of funds available for maintenance is used to cover personnel costs. Little is left for actual maintenance. Corruption and undue influence from partisan interests lead to misallocation of funds, faulty construction and other inefficiencies. Farmers dissatisfied with irrigation services are unwilling to pay

irrigation service fees, which further inhibits mobilization of sufficient funds for maintenance.

The pattern of "build-neglect-rebuild" and poor maintenance management have widespread and serious consequences. These include the shrinking of irrigation service areas, inefficient and inequitable distribution of water, loss of capacity to measure and control water, and waterlogging of otherwise productive land. These problems result in loss of agricultural productivity, declines in farm income, inability to collect water charges from farmers, and substantial debt burdens on governments which must repay loans for premature and repeating rehabilitation projects.

Since inadequate maintenance of irrigation systems has such serious consequences, the relative lack of attention by governments and international development agencies to the maintenance problem is remarkable. It is this lack of attention to maintenance that we refer to as the *maintenance paradox*. The paradox is: *If the maintenance problem is so serious, why is there so little attention given to solving it?*

Disincentives for adequate maintenance of irrigation systems effect senior government officials, irrigation agency staff, farmers and international development agencies. These disincentives are especially strong in centrally-managed irrigation bureaucracies where the government still acts as the primary provider, rights-holder and payer of irrigation services.

Table 1 displays common disincentives toward irrigation maintenance affecting key stakeholders in a conventional top-down administrative setting. These disincentives are especially pronounced in such a setting but they are not unique to it. Disincentives leave farmers, governments and international agencies without sufficient motivation to invest in maintenance at levels which would ensure the functional sustainability of irrigation systems.

This Guide adopts the premise that the general lack of commitment toward solving the problem of

Table 1.
Examples of incentive deficiencies for irrigation maintenance

Stakeholder	Incentive Deficiencies
Senior Government Officials	■ Low political benefits, high opportunity costs ■ Low, delayed visibility of benefits of maintenance ■ Low budget priority. Rehabilitation projects create political support
Irrigation Agency Management	■ Budget allocations unrelated to fee collection rates ■ Internal political benefits of maximizing employment rolls ■ Accountability to internal hierarchy simpler than accountability to water users
Operational Staff of Irrigation Agencies	■ Maintenance lacks professional appeal ■ Deterioration rewarded by rehabilitation projects ■ Accountability to internal hierarchy instead of accounting to water users ■ Internal accountability mechanisms do not reward good maintenance
Water Users	■ Irrigation infrastructure seen as government property and responsibility of government to maintain ■ No relation between payment of water fees and quantity or quality of maintenance ■ No clear water rights ■ Not involved in priority setting for maintenance works
Foreign Donors	■ Difficulty in monitoring the use of resources for maintenance ■ Difficulty in monitoring the benefits of effective maintenance ■ Pressures to perpetuate the financing of capital intensive projects, such as rehabilitation, modernization and expansion ■ Reluctance to fund recurrent costs

inadequate maintenance of irrigation systems has its roots in a one-sided and partial understanding of what maintenance is about. This perception focusses exclusively on the questions of *how to do* maintenance and *how to pay for* such maintenance activities. In the following we refer to this perception as the *production perspective*.

However, maintenance has two sides, like the two faces of a coin. What we need to consider additionally, in order to approach solutions to the above-stated maintenance paradox and the related incentive deficiencies is an understanding of maintenance as a *provision*. Major problems of maintenance, in this perspective, are due to the fact that maintenance *provision* is not well structured or does not function altogether. More seriously, in most cases key questions of maintenance provision are not discussed at all. Who provides maintenance to whom? Who are other stakeholders involved in the provision process and what functions do they assume or what support services do they provide? What are the mechanisms that govern the relationships and exchanges between the stakeholders in these provision processes? On the basis of what kind of agreements, rights, contracts or common practices does the provision of maintenance and of the supporting services occur? Do these arrangements provide incentives to engage in the relationship? How can non-compliance with provision agreements be enforced? These and other questions relating to *institutional arrangements* for maintenance are at the center of a perception we refer to as the *provision perspective*.

We contend that a comprehensive treatment of the topic of maintenance requires consideration of both the provision and the production of maintenance services.

2. The Conceptual Framework

As mentioned above, this Guide builds on a conceptual framework – the *provision perspective* – that differs substantially from the dominant maintenance paradigm. The key elements of this concept are the following (see also Table 2).

- As stated before, maintenance is defined here as a *provision* and not simply as a technical task. More precisely, maintenance is looked upon as a *service* closely linked to the major infrastructure services in irrigation: the provision of infrastructure and water delivery.
- This Guide raises awareness of the fact that maintenance services are prone to *particular inherent problems* that need to be taken into account. Amongst others, maintenance services often have the features of *collective goods* or *club goods*. Moreover, they are so-called *"future goods"* in many cases – i.e. the benefits of maintenance often accrue in a distant future. And maintenance provision often is highly *intransparent*, i.e. it is difficult in many situations to check whether or not maintenance has actually been done. Characteristics like these may induce particular consequences and require particular approaches to deal with them.
- In this Guide we contend that maintenance problems are related to *three distinct domains* that are highly interrelated:
  - The technical domain
  - The economic/financial domain
  - The institutional/organizational domain

  Emphasis in this Guide is given to the *institutional domain* which has been widely neglected so far when dealing with maintenance issues.
- Irrigation in general and maintenance in particular are perceived as *multi-actor enterprises.* Service provision involves different roles: the roles of provider, arranger, payer, consumer and often also the

Table 2: Comparison of the production perspective and the provision perspective for maintenance in irrigation.

Production Perspective	Provision Perspective	Reference in this Guide
Maintenance defined as a technical task	Maintenance defined as a service provision	Para 2.1
Maintenance as a complementary task to system operation (O&M)	Maintenance as a secondary service to the primary services of "infrastructure provision" (PI) and "water delivery"	Para 2.1
No attention to special "goods character" of maintenance	Deals with consequences of special "goods character" of maintenance (collective or club good; future good; good with low transparency)	Para 2.3 Module 8
Focus on the technical and the financial domain	Focus on the institutional domain	Para 2.3 and chapters 3 and 4 Modules 5 to 10
No attention to involved stakeholders	Special focus on involved stakeholders and their roles, rights and functions	Para 2.4 Modules 4 and 5
No attention to questions of coordination and motivation of stakeholders	Central focus on the governance of service relationships and hence on coordination and motivation of stakeholders	Chapter 3 Modules 6, 7 and 9
Often (but not necessarily) low attention to performance orientation	Performance orientation emphasized through definition of "level of maintenance service provision"	Para 2.2 Module 1
No situational differentiation of maintenance strategies	Emphasis on situational differentiation of strategies for maintenance provision	Chapter 4 Implicit in all Modules

roles of arbiter, auditor and regulator. In most cases these roles are assumed by different organizations, groups or individuals. A core requirement for successful maintenance service delivery is the *coordination and motivation* of these multiple actors towards a common performance goal.

- To achieve such coordination and motivation means to achieve *accountability*. The Guide defines and discusses the two important dimensions of accountability:
  - the *service arrangement* and
  - the *institutional framework*

  Strategies for the improvement of maintenance will largely depend on the strength of the service arrangement that is in place and of the supportiveness of the institutional framework.
- Given the service perception of maintenance promoted by this Guide, a *performance orientation* of maintenance – a defined *"level of maintenance service provision"* – needs to be introduced. A realistic level of this kind will necessarily be a function of the technical and economic constraints that impinge on the irrigation system. However, here again, the definition of this level will also depend greatly on the quality of the service arrangement and the institutional framework conditions. To define and achieve an *optimal level of maintenance provision* in diverse situations set by these constraints is hence a challenge to which this Guide hopes to make a contribution.

2.1 Maintenance in the context of infrastructure service provision

What are "infrastructure services"?

In order to understand service provision in irrigation and the role of maintenance, it is useful to look more closely at what is meant by *infrastructure services*. Infrastructure services are those services that can be provided by means of a given piece of infrastructure.

Unbundling sets of infrastructure services reveals the following:

- The most general infrastructure service consists of making infrastructure available for use, the *provision-of-infrastructure* (PI) service. For example, a road is made available by government for use by car traffic; a house is rented out by the owner to be used by a tenant; a car is rented out to a temporary user.
  In some cases such *primary* PI-services may be subdivided into subsets of PI-services. For example, one PI service provider might construct a railway, while another makes available rolling stock. PI services in road transport might consist of provision of the roadways themselves, provision of trucks and provision of goods containers.
- Subsequent to the PI service, some infrastructure services consist of the performance of certain functions by means of the respective infrastructure, e.g. *the delivery of certain material and immaterial goods*. Examples of such "performance services" (PS) are the conveyance and delivery of drinking water by means of a buried pipe system, the conveyance and delivery of electrical current through a net of transmission line, or the conveyance and delivery of irrigation water by means of a network of irrigation canals.
  Also, the function of a pump station "to lift water from level A to level B" can be perceived as such a performance service. The service of the pure transport and distribution of a good to the points of delivery may be enriched by having the service deliver the good in a certain quantity and quality, at a certain time and at a particular point. Table 3 lists the performance services provided by various physical components of irrigation and drainage schemes.
- These two *primary* services, i.e. the provision-of-infrastructure service (PI) and the performance service (PS) can only be provided if the providers themselves receive some indispensable (internally or externally provided) *secondary* services. In the case

Table 3: Performance services of physical components of irrigation and drainage schemes (Burton 2000 in MAINTAIN Thematic Paper No. 8)

Component	Levels	Performance service
Canals	Primary Secondary Tertiary Quaternary	To convey water
Drains	Primary Secondary On-farm	To remove water from the field
River weir	Main canal	To divert and control irrigation supplies
Headworks	Main canal intake	To take in water to the main canal. This may be a group of structures, including a river weir, head regulator, settling basin, and measuring structure, or one structure such as a pump station.
Pump station	Main canal Main drain	To lift water to command level for irrigation. To remove water from drainage channels which are below river level
Settling basin	Main intake canal	To settle out sediment
Cross regulator	Primary and secondary canals	To raise and maintain water surface at design elevation
Head regulator	Primary, secondary and tertiary canals	To regulate discharge entering a canal
Measuring structure	Primary, secondary and tertiary canals	To measure discharge for operational purposes
Aqueduct	All levels of canal	To pass canal over an obstruction (another canal, a drainage channel, etc)
Culvert	All levels of canal or drain	To pass canal or drain under an obstruction (road, drainage channel, etc)
Drop structure	All levels of canal or drain	To “drop” the canal or drain bed level in a safe manner. Used to slacken canal or drain slopes on steep land
Escape structure	All levels of canals	To release water from a canal into the drainage network in the event of oversupply or under-utilisation.
Syphon underpass	All levels of canals	To pass the canal below an obstruction such as a road or drainage channel.
Distribution box	Quaternary canal	To distribute water between quaternary channels
Night storage reservoir	Main canal or on-farm	To store irrigation water during the night for release during the day. Main canals can thus operate 24 hours/day whilst lower order canals can be operated during the daytime.
Tubewell	On-farm	To abstract groundwater for irrigation. Often used in conjunction with surface water system
Bridges	Road bridges Foot bridges	To allow human and animal traffic over the canal or drain
Roads	Inspection roads Access roads	To gain access to the irrigation system and villages. For inspection and maintenance

of the PI services these are services of maintenance, rehabilitation and modernization of the infrastructure. In the case of the PS-services these are services of system operation and accompanying maintenance ("O&M").

- Generally, a number of other services are required to enable and facilitate the primary PI and PS services described above. These include engineering design, contracting, billing, budgeting, financial management, coordinating with other actors, public relations and so on. We term these *supporting services*. We distinguish them from primary and secondary PI and PS services in terms of the directness of their relationship with the process of arranging and providing the irrigation water to clients. While measurement of water flows is an integral part of delivering irrigation service, preparing bills for the service is only indirectly related and is considered a supporting service. External organizations and groups are sometimes called upon to provide these supporting services, though they can be supplied internally as well.

In such a context, maintenance can be perceived as a service to the supplier of the infrastructure, since maintenance is required to keep the infrastructure in good condition so that it can be used to deliver a service to clients. Alternatively, maintenance may be perceived as a service to the user of the infrastructure, enabling the user to deliver a certain good by employing this infrastructure. Whether and to what extent maintenance is a service to the PI agent or to the PS providers is determined by the property rights associated with the infrastructure and by the terms of the agreement between these two parties. This opens the possibility that maintenance obligations may be split. For example, the supplier of the PI service may remain responsible for maintenance related to the long-term preservation of the infrastructure asset, while the provider of the PS service may be responsible for

maintenance related to day-to-day operation of the infrastructure facility.

In this Guide, we will return again and again to the character of maintenance as a service provision. In Module 4 of Part Two we present an instrument that allows identification of the services and supporting services that are provided in a complex network of involved actors. In chapter 2.3, we describe a number of inherent problems related to the service character of maintenance. In Modules 5 to 8 we present ways to overcome some of these problems.

2.2 Performance orientation of maintenance provision

Vague or non-existing target levels for irrigation services are among the major causes for incentive deficiencies. If such "levels of service" have not been defined, there will be no benchmark against which to judge the efforts and contributions of the various actors. But how to create incentives for a high quality service provision or for improvements of the actual provision if these performance levels have not been defined? How to judge maintenance provision if no target level for such a provision has been specified beforehand? Thinking in such terms, it is quite remarkable that Burton states in MAINTAIN Thematic Paper No. 8, that "*to the author's knowledge little, if any, work has been done on assessing farmers' desired level of service in smallholder irrigation schemes in developing countries*".

To define an agreed upon target level of service provision is essential for other reasons as well. Different actors may have different aspirations and diverging levels of expectations may become the source of conflicts and disincentives. Examples abound in irrigation where ambitious scheme performance levels have been formulated in the planning phase but where

farmers failed to contribute to the achievement of such target levels.

This is why, in this MAINTAIN-Guide, we advocate efforts to define service objectives and performance standards as essential for improvements in maintenance provision. Doing this we point to recent definitions of maintenance such as those mentioned below. These definitions include a reference to system performance and often specify a particular level of performance as the criterion for successful maintenance. Particularly the first two definitions place very clear emphasis on system functionality – its output – rather than on providing a given input level for the maintenance process.

Maintenance is...

... the upkeep of facilities with the goal of efficient operation, minimum breakdowns, good appearance, reasonable costs, extended useful life, and safety – Krause and Temple (1988)

... a management response to the deterioration of the physical condition of irrigation systems that threatens to make it impossible to achieve operational targets – Karunasena (1993)

... any action required to either return an irrigation system to or keep it at a desired performance level – Thoreson et al. (1997)

Performance orientation is an essential element of what we mean by "service orientation": a change from a supply driven, input-oriented perspective to a demand driven, output and performance oriented view of maintenance efforts. Using the insights we have gained before with respect to the character of maintenance as a service provision, we base the discussions of this Guide on the following MAINTAIN definition of maintenance.

The MAINTAIN definition of maintenance

Maintenance is …

... both a technical activity and a service provision aimed at keeping irrigation infrastructure at a desired performance capacity or to restoring it to a particular capacity. It is a service supplied to the providers of the infrastructure and/or to those who deliver certain goods by means of this infrastructure.

In Module 1 we discuss in detail approaches to objective determination for irrigation maintenance. In this Module, we also deal with the question of how to modify objective determination under different institutional conditions.

2.3 Inherent problems of maintenance provision

When we perceive maintenance as a service we need to be aware that service provision is prone to a particular set of problems.

What are inherent problems of maintenance service provision?

As mentioned before, the particular problems of maintenance services emerge when we look at the relation among the exchange partners of such services.

The roots of such problems go back to the facts that

- Maintenance services often have the features of *"collective goods"* or *"club goods"* (see Box 1)
- Maintenance services generally have the features of "*future goods*"
- Maintenance services in many cases are highly *intransparent services*.

All of these facts contribute to *one central problem in maintenance service provision*: it may be very difficult for the clients or customers of the service to sufficiently influence the provider to ensure that provision corresponds to clients' needs. We call this central problem the problem of *"feedback*

deficiencies". Such feedback deficiencies are among the prime causes for incentive problems related to maintenance (not only in irrigation).

Maintenance as a collective good or club good

What are characteristic problems of services?

In many cases a maintenance service is a so-called "collective good", more precisely, a "club good". This means, that the service is not provided for an individual but for a group. For collective goods, sometimes some people in the group that do not pay for the service cannot be excluded from benefiting from it.

Box 1 – Private and Collective Goods

Private goods are goods (or services) we would normally acquire by purchase (e.g. an item of clothing, a hair cut). These are goods to which the so-called "exclusion principle" applies, i.e. those individuals who have not paid for them can be excluded from their consumption. Private goods are also goods to which the "competition principle" applies. This means that the consumption of a unit of this good by a consumer reduces the availability of the good to other consumers by a certain degree.

Collective goods are goods to which the two above-mentioned principles sometimes do *not* apply. Where the non-excludability relates to open access to the public, e.g. the use of goods such as public safety or an anti-air-pollution measure, then the term *public goods* is applied. In such cases, a member of the public who has not paid – i.e. in this context not paid any tax – cannot be excluded from consumption of the goods. The competition principle is also not applicable, in that the "consumption" of public safety by a "consumer" does not have any adverse effect on corresponding consumption by other beneficiaries.

Where the non-excludability of certain collective goods relates to a certain group of consumers – e.g. motorists on a road where a toll is levied – the term *club goods* is applied. This denotes goods which potential consumers not belonging to the club (e.g. of those who have not paid the toll) can be prevented from enjoying. Within this group, the competition principle is of no significance. The use of the good in question by a member of the group in no way constrains the use of the good by the others.[1]

1 This example clearly illustrates that there is rarely such a thing as "purely" public goods such as public safety. In the case of motorway use, from a certain number of users upwards the traffic jamx caused can indeed bring the competition principle into play.

The problems associated with such goods make it difficult for providers and clients to "control" their provision. With goods of this type there is no market, as non-payers – so-called "free riders" – are also able to consume the good in question. This also means that no price can be formed in the strict sense, i.e. there is no "equilibrium price" to harmonise supply and demand. (Notwithstanding the fact that fees can nevertheless be set). From the lack of price formation it follows that individual clients also lack a key means of influencing the supply. Consequently, also a "feedback deficiency" emerges between the service provider and the client: The provider cannot exclude non-paying users, and in turn the individual clients have no direct means of influencing the quantity or quality of service provision. This normally leads to a serious breakdown of incentives for further service provision. Even customers who are willing to pay for the service will cease to do so when they become aware that extensive free-riding exists. With increasing free-riding the financial basis for the provision of the service will erode and provision will eventually stop.

The free-riding problem is dealt with in Module 8 and some strategies are provided to help overcome such problems.

Maintenance as a "future good"

The maintenance service which is exchanged between a supply and a demand side has a characteristic which has important impacts on incentive creation: it is a "*future good*". Future goods are goods or services, the benefits of which do not emerge until some point in the future, but which have to be paid for in the present. A well-known problem with future goods is the fact that they are subject to the *law of "undervaluation of future goods"* (a law well known in the insurance business). This law states that many consumers have a

tendency to overly discount future needs and hence are not willing to make the full necessary outlay in the present for goods which they cannot use until the future. Excessive discounting drastically reduces incentives for maintenance. Such a tendency will be particularly pronounced with poor farmers in developing countries.

When looking at the economic incentives for maintenance, this discounting tendency and the resulting perception that different actors have of the present value of benefits needs to be taken into account. Module 3 of this Guide introduces an approach for a rapid economic assessment that includes such considerations.

Maintenance as an intransparent service

The service features of maintenance entail a further potential problem, the frequent *intransparency* of services. Intransparency means that, as a non-professional, the customer/client is unable to fully judge the value of the service being provided by the provider, who is an expert. Water users, for example, seldom possess detailed engineering knowledge and hence, in cases where they arrange the provision of maintenance services, it will be difficult for them to monitor and evaluate the more sophisticated maintenance works to be done.

This lack of transparency inherent in some intransparent services automatically introduces a pronounced *"feedback deficiency"* into the service relationship. Particular institutional arrangements are needed to solve problems of this kind and to prevent incentive problems having their roots in feelings of "loss of control" on the part of those who demand and benefit from such maintenance services.

Module 6 of this Guide introduces approaches that help to deal with feedback deficiencies of this kind.

2.4 The disciplinary domains of maintenance provision

When thinking about maintenance problems, people tend to relate these problems to the technical infrastructure: Silted-up irrigation ditches, embankments covered with weeds, rusted and warped sluices, sections of ditches with slope failure, undercut and broken-off wing walls, weirs and drop structures, etc. are common symptoms of maintenance problems. These symptoms make it tempting to mistake effects for causes, and to look exclusively for technical solutions to maintenance problems. Since damage of this kind is often not due merely to technical problems, this may simply initiate a repeating cycle of technical rehabilitations.

In this Guide, we perceive maintenance in the context of three major domains fitting within the overarching framework conditions:

- The *technical/physical* domain (e.g., technology, design, construction, physical inputs)
- The *economic/financial* domain (e.g., costs, benefits, financing)
- The *institutional/organizational* domain (e.g. stakeholders, agencies, accountability, governance)

All of these domains need to be considered when dealing with maintenance in a comprehensive way. As noted in Table 2, the production perspective on maintenance puts the major focus on the technical and financial domains. In contrast, the provision perspective concentrates mainly on the institutional domain. This concept can be visualized by a triangle embedded in an ellipse that represents the overall framework conditions, as shown in Fig. 1.

A detailed discussion of the technical domain is not the focus of this Guide. However, even in situations where institutional problems appear to be predominant, the technical manifestations of institutional deficiencies need to be assessed and documented.

To satisfy this need, Module 2 in Part Two of the Guide presents a procedure for "Rapid Asset Appraisal". For more detailed information on Asset Appraisal and Asset Management techniques reference can be made to MAINTAIN Paper No. 8.

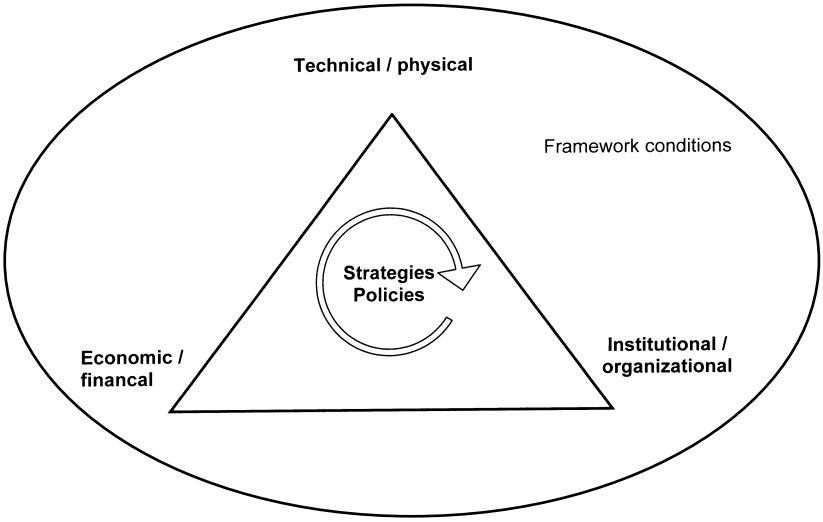


Fig. 1: The major disciplinary domains related to the issue of maintenance

An in-depth discussion of the *economic* domain in irrigation maintenance will have to examine not only the costs of maintenance, and the resulting level of irrigation service, but also the benefit stream generated by the service provided and the impact that different levels of maintenance have on this benefit stream.

This is a discussion which is neither attempted in this Guide nor will it be a realistic undertaking in most practical irrigation situations. The complex cause-effect relationships, discussed more in detail in Module 3 of Part Two, are difficult to establish and the necessary data are not available under normal circumstances. Still,

incentives for stakeholders, especially for water users, to engage in maintenance are predominantly of an economic nature. Hence some economic "yardstick" is needed when devising a detailed maintenance strategy.

To solve this dilemma, the Guide offers the concept of a "Rapid Economic Assessment" of maintenance needs (already mentioned above) in Module 3.

The reader may also refer to a recent study by HR Wallingford (Skutsch 1998), which highlights the issues involved in the economic domain, without resorting to a fully detailed economic analysis.

2.5 Irrigation and maintenance as multi-actor enterprises

The so-called "administrative paradigm" has been the dominant approach toward irrigation development in many developing countries since the colonial era. Medium and large irrigation schemes built by government engineers and contractors were, after construction, operated and maintained by government staff who were provided O&M manuals and directed and financed from above. Administrative procedures controlled with little if any formal participation by farmers.

The social landscape in developing countries has changed greatly since the demise of colonialism. The top-down administrative paradigm has persisted in many countries, at least superficially, despite increasing democratization, economic liberalization and the commercialization of agriculture, which render it increasingly obsolete. Today, irrigation schemes all over the world generally consist of multiple stakeholders who have contending interests and divergent perspectives. Hydraulic networks of irrigation schemes tend to cut across socio-economic categories and local

government boundaries. Differences between head and tail ends of canals in water delivery service and maintenance requirements generate social differences and tensions.

As we have seen in section 2.1 and will further discuss in section 3.2 and Module 4, a number of distinct key *service roles or functions* are directly involved in irrigation management services. These are to:

- provide the primary irrigation services, i.e.
  - provide the hydraulic infrastructure,
  - provide the water delivery service (water capture, water conveyance, water distribution, water allocation etc.);
- provide the secondary services, i.e. those services that are integral to the primary services (operation and maintenance);
- provide the supporting services (information provision, coordination, representation, etc.);
- arrange the primary, secondary and supporting services (i.e. select providers, define terms of reference, conclude agreements or contracts, monitor provision etc.);
- use the services; and
- pay for the services.

These roles may be performed by different kinds of entities, such as government agencies, water users associations, or contracting companies. Even if we restrict the discussion to the secondary service of irrigation *maintenance* provision, there is normally a large number of involved stakeholders. As an example, Table 4 reveals how vast the number of interrelated actors can be in the field of maintenance. It lists all the different organizations, entities and groups with whom the Nienburg/Weser Maintenance Association in Germany has working relationships in order to accomplish its purposes.

Table 4 : Organizations, entities and groups receiving and providing services / supporting services from and to the Nienburg Maintenance Association in Germany.

(Source: Huppert and Urban, 1998)

1. Nienburg District Association (Umbrella organization)
2. Lower District Water Authority
3. Lower District Conservation Authority
4. Upper District Water Authority
5. Upper District Conservation Authority
6. Independent Conservation Associations
7. “29” Associations
8. Farmers’ Association
9. Members
10. Obstructors (farmers objecting to rights of way)
11. Contractors
12. Own engineering offices
13. External engineering offices
14. Consultants
15. Other interested parties
16. Agriculture authorities
17. Water management authorities
18. Conservation authorities
19. Banks
20. Standards authority
21. Subsidizing agencies
22. Court of law
23. Public prosecutors
24. Neighborhood associations
25. Fishery organizations
26. Holders of water rights
27. Communities
28. Town and country planning authorities
29. Raw material extraction companies
30. Forestry authorities
31. National and regional bodies
32. Social environment

3. Institutional Requirements for Maintenance Provision

If we accept that irrigation maintenance is a service involving multiple actors with different interests and constraints, then there are three key challenges for ensuring effective service delivery. These are:

- To design the service provision process so that institutional arrangements are compatible with the existing *institutional framework conditions.* (To devise market-based arrangements for service exchanges, to take an example, in an institutional set-up without clear laws or traditions of property rights and without strong and independent judiciary bodies that can enforce such laws, will be bound to failure).
- To develop or improve institutional arrangements such that they bring about effective *coordination* among the involved actors.
- To design institutional arrangements such that they provide *incentives* which ensure *motivation* for all actors in a service arrangement to be accountable to one another for provision of the agreed service.

The terms *"institutions"* and *"institutional arrangements"* in this Guide are used to indicate formal and informal rules and mechanisms (of a regulative, normative and cognitive nature) that provide stability and meaning to social behavior.

We define *accountability* as the capacity to ensure that the agreed service objectives, performance standards, procedures and payments contained in an irrigation service arrangement are complied with by the stakeholders involved.

Fig. 2 depicts such a concept of service provision schematically. It shows the two important dimensions that have to be dealt with in any attempt to develop or improve institutional arrangements – the *external institutional environment* and the *service arrange-*

ment. The following subchapters 3.1 and 3.2 describe these dimensions.

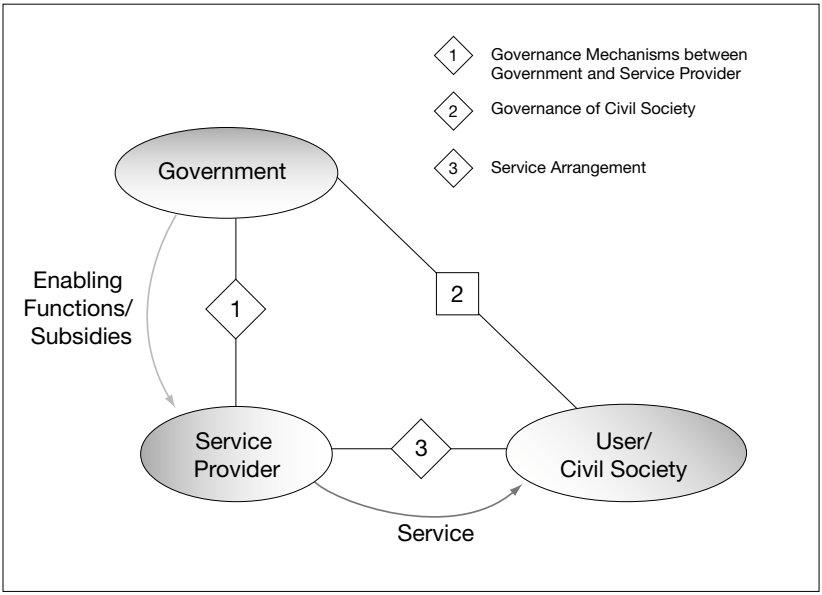


Fig. 2: Institutional Arrangements for Service Provision

3.1 The external institutional environment

We use the term "external institutional environment" to mean all the legal, policy, organizational, socio-economic and cultural factors which affect but are not part of the direct service relationship itself. There may be particular laws, prescriptions and regulations, that effect the service provision. There may be conventions, political processes and other factors external to the irrigation system that have to be taken into account. How can we visualize such a multi-facetted construct?

In Figure 2, we represent the external institutional environment by two bundles of external factors that strongly impinge on the service relationship.

- The first one relates to all the institutions that govern the relationship between the government and the service provider (whether this is an irrigation agency, a water user organization, a private firm or some other provider).
- The second one refers to all the institutional mechanisms that govern the relationship between the government and the service recipients (as part of civil society).

Based on such a perception, one may assume a supportive institutional environment, if there is (see World Bank 1994 b):

In general,

- A government with high legitimacy,
- Accountability of political and official elements of government (media freedom, transparent decision-making, accountability mechanisms),
- Respect for the rule of law,
- A satisfactory public perception of the accountability of civil servants,
- A high degree of independence of the judiciary,
- A satisfactory degree of administrative capacity in the bureaucracy.

With respect to the relationship "government – service providers", we consider that there is a supportive institutional environment if there is:

- A government which is competent to formulate policies and define its own role and core competencies with respect to service delivery,
- A well established framework for economic activity (laws on property rights, laws on companies (bankruptcy laws), banking, competition, foreign investment, establishment of regulatory bodies, etc.),
- Existence of formal mechanisms and informal channels to facilitate communication between the public and the private sectors,

- Sufficient strength in the public procurement systems (transparency of procedures, adoption of bidding documentation, competitive bidding, staff training, etc.).

With respect to the relationship "government – users (civil society)", we consider that there is a supportive institutional environment where the following conditions exist:

- Respect for human rights,
- Political decision making based on strong participation of relevant groups of civil society,
- Microlevel accountability through beneficiary participation in local decision making,
- Easy access of users to fair legal procedures and other conflict resolution processes,
- A clear and transparent distribution of property rights that is consistent with the intended service delivery system (see Module 5),
- A secure right of water user associations to organise.

3.2 Service arrangements

When trying to understand the exchange of services and returns within a network of interacting actors, the issue arises of how the system of exchanges needs to be organised in order to be functional. A first step towards answering this question is to focus on just two exchange partners as shown in Fig. 3. Both parties must address the basic question of how to ensure that services and returns agreed upon are actually provided without one party taking undue advantage of the other. In other words, what needs to be established is a system of agreements, contracts, rules and/or procedures that "govern" the exchange relationship. Such institutions should bring about sufficient *coordination* and *motivation* to make the exchange happen to the satisfaction of both parties. The same principle applies in a network of interdependent actors where a

multitude of bilateral exchange relationships need to be coordinated. In the following, we refer to the set of coordination mechanisms that organize a particular service exchange as to a *"service arrangement"*.

The provision of any irrigation service involves interactions between service providers, service recipients, service payers, government policy makers and regulators. At the operational level, a service provider may adjust gates, measure and distribute water and apply sanctions against rule violators. Water users may provide payment for service and convey information and recommendations or complaints to the service provider. Indirectly, tax payers may subsidize the cost of irrigation in return for lower costs of food at the market. Governments may provide subsidies for irrigation in return for compliance by water users with water regulations. Service provision involves inter-dependent relationships among stakeholders.

For provision of commercial services, as depicted in Fig. 3, the customer or client normally assumes three different functions: he acts as the *arranger, the payer and the consumer of the service* – all at the same time. The commercial irrigation farmer who asks a private firm to install a pump for him, arranges this service, pays for it and is the one who (hopefully) is able to make beneficial use of this service. In this triple role, the farmer has various possibilities to influence the service

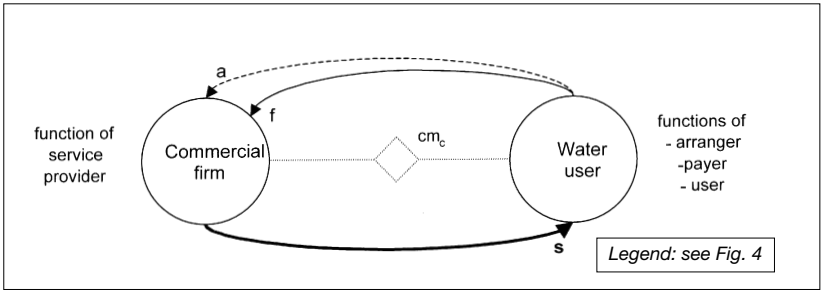


Fig. 3: Commercial irrigation service provision: integration of functions at the client side

to be provided. *As the arranger*, the farmer selects the service provider, assigns the terms of the service and authorizes the provider to execute the necessary works at his pumping station. Both in the selection process and in the formulation of the terms of contract the farmer can make use of the authority to determine what kind of service to buy. *As the payer,* he or she may withhold or even refuse payment in case the service has not been provided according to the contract agreement. And *as the consumer or user* of the service, the farmer is the one who can express satisfaction or dissatisfaction during the provision process and ask for modifications. It is the direct interaction with the

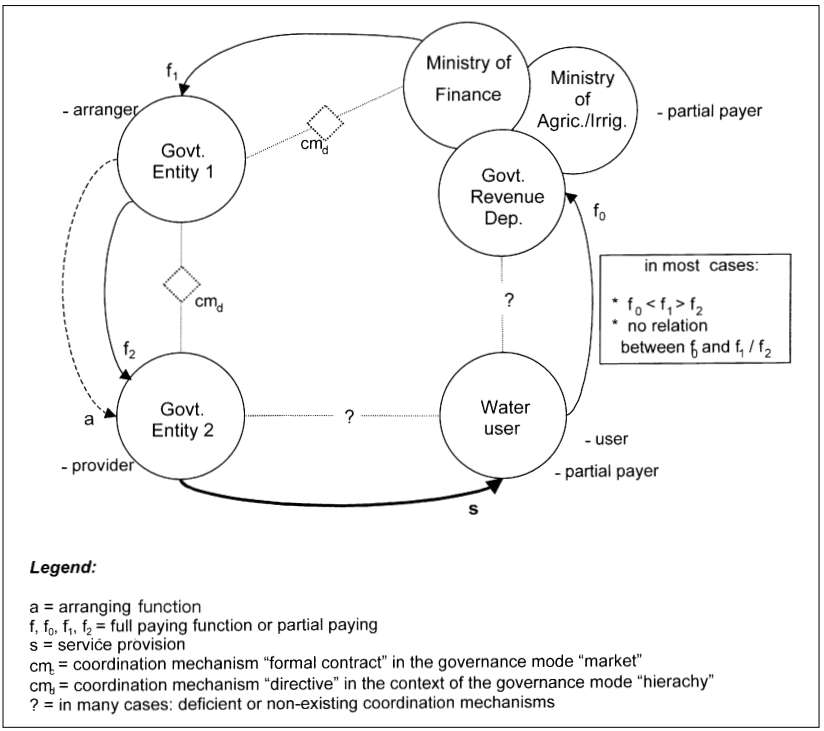


Fig. 4: Irrigation service provision by government entity to water users: splitting of functions at the client side

service provider that allows the farmer to influence the provision process according to his own needs. If expectations cannot be fulfilled he/she can either alter the terms of the contract or – at least for the next time – look for a different provider.

It is exactly this crucial feedback loop from the consumer to the provider that is often missing in non-commercial service provision, as is shown in Fig. 4. Here, in many cases the functions of the arranger, the payer and the user or consumer of the service are split. The service receiver (e.g. irrigation farmers that receive irrigation water from a government agency on a subsidized basis) might neither be the full payer nor the arranger of the service that is being provided (see Fig. 4). However, with well-established *mechanisms of coordination* and control between the different actors even such arrangements can function effectively. In practice, however, this is often not the case. In the arrangement shown in Fig. 4 for example, we see, that coordination mechanisms between the water users and the service providers, payers and arrangers are deficient or non-existent. It will hence be difficult to tailor the service provision such that it takes the needs and preferences of these water users into account. Even through their payment decisions the water users can hardly influence the provider, there is no direct connection between the payment f_0 of the water fees and the budget f_1 and f_2 provided for provision of the service. The feedback loop that allows easy adjustment of the service provision to the wants and needs of the client is lost here. A service provision with deficient service arrangements like these stands little chance of functioning effectively.

Based on such considerations, we can say that service arrangements normally will be strong, if there is:

- agreement among the involved parties upon clear objectives of the service provision,

- agreement upon well specified terms of the service delivery,
- agreement upon procedures and performance standards
  (transparent, measurable and monitorable),
- a well established set of coordination mechanisms that govern the relationships between the different actors,
- a possibility for the client side to influence the provision process, if so agreed,
- an accepted level of payments or returns and a transparent payment plan,
- ability and willingness of the client to pay,
- a closed "feed-back loop" between service provision and payment for that service,
- the possibility for independent technical/financial audits,
- arrangement for transparent accounting procedures,
- a mutually respected conflict resolution framework,
- a high degree of client satisfaction with service delivery.

Module 6 in Part Two of this Guide applies such considerations to maintenance service provision. It presents guiding principles on how to analyse and improve service arrangements for maintenance provision in irrigation.

4. Developing Institutionally Viable Maintenance Strategies

4.1 "Strategic Institutional Positioning"

The MAINTAIN concept emerged from the series of case studies and thematic papers, listed in the inside front cover of this Guide and at the end of this volume. These studies showed that the inclusion of institutional issues in the debate on maintenance has one particular consequence: Since institutional contexts can vary so drastically, it appears essential to differentiate basic contexts that require different approaches to maintenance improvements.

MAINTAIN responds to this requirement with "Strategic Institutional Positioning" (SIP). Such an approach accommodates all the elements of the conceptual framework discussed above but permits this to be done on the basis of a situational differentiation.

What is the purpose of Strategic Institutional Positioning (SIP)?

Since institutional environments can be quite diverse, approaches to solving maintenance problems – the "maintenance strategies" – will have to vary as well. It goes without saying that maintenance efforts in the Central Valley in California (see MAINTAIN Case study No.6) will have to have a different thrust and will confront different institutional constraints than similar efforts in developing countries such as Jordan and India (see MAINTAIN Case studies No.3 and 5). This will be even more true for a comparison with maintenance activities in least developed countries such as Haiti (see GTZ-Publication Series 263). While it is impossible to provide "recipies" for approaching every particular site-specific situation, we can define the characteristics of some basic contexts that will then give a certain orientation and guidance with respect to a particular case in question.

What is Strategic Institutional Positioning (SIP)?

SIP first attempts to visualize the important factors of the institutional environment in a two-dimensional space. This is an exercise which can only be

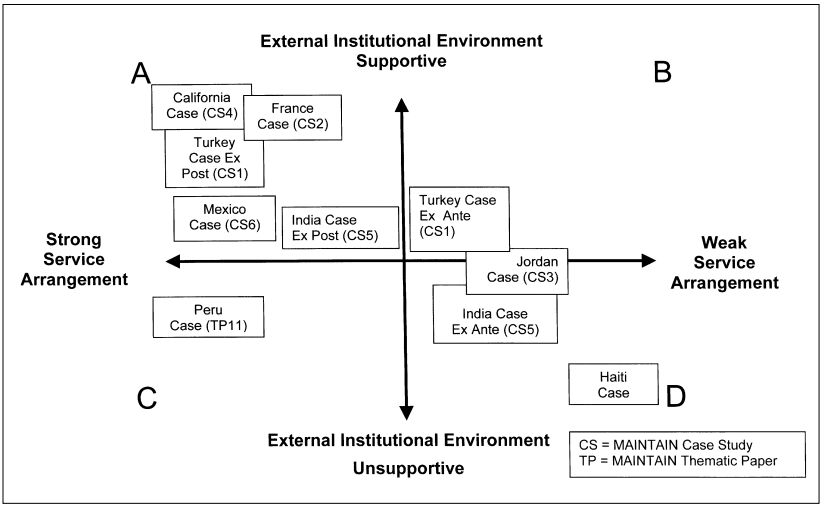


Fig. 5: Strategic Institutional Positioning

implemented in a fairly crude way. SIP then requires indicating the "position" of the particular irrigation system at hand in this two-dimensional space. Such a position necessarily will be a rough approximation. However, the philosophy behind such a "quick and dirty" procedure is that it may be better to start maintenance efforts with a rough idea of the right strategic option in a given institutional environment than to neglect the institutional context altogether, embark on ambitious programs to rectify the consequences of deferred maintenance and then realize that people just go on deferring maintenance activities.

How can "positioning" be done?

To implement SIP, the evaluating team must consider the context of the given irrigation scheme and assess the two dimensions of "strength of service arrangements" and "supportiveness of the external institutional environment" discussed in sections 3.1 and 3.2. Based on the resulting ratings a positioning of the particular problem situation can be discussed. The important point here is *not* to attempt to deduct exactly

the position of the given maintenance problem. Rather SIP should induce discussion and communication between the involved stakeholders about the appropriate maintenance strategy to be followed. In other words: the purpose of the instrument is *not* to provide a mechanism that "automatically" leads to a strategy but to bring about discussions that create awareness about the relevant factors in the institutional environment.

What are the basic maintenance strategies in extreme positions?

Such a positioning in one of the four quadrants of the strategic space indicated in Fig. 5 will bring into the discussion the following four basic strategy options:

Strategy option A: Strong service arrangements – supportive institutional environment

This is the best case scenario. With both well-established service arrangements and a supportive external institutional environment, the maintenance strategy has to follow a very comprehensive approach, since the binding constraints that cause the maintenance problems may be of a very diverse nature. If the particular maintenance problem is positioned in an institutional environment that roughly corresponds to a position near the upper left corner of Fig. 5, then this might indicate that there are no or few institutional causes for the maintenance problems at hand. The problems, if any, are in most cases *not* related to institutional weaknesses and require a screening of other problem domains, predominantly those of a technical and an economic/financial nature. The fact that there are few or no institutional weaknesses related to the framework conditions or to the service arrangement points to a very high level of performance, a level that will seldom be reached in developing countries. A detailed analysis of the remaining problems will be necessary and approaches of "Asset Management", as outlined in MAINTAIN Thematic Paper No. 8, may be useful.

Situations in the upper left corner of Fig. 5 as they might occur in industrialized countries are *not* the focus of this Guide. This is why detailed Asset Management approaches are not a central feature of the set of Modules in Part Two of this book. However, for situations at the fringes of the upper left quadrant, "Rapid Asset Appraisals" as introduced in Module 2 may be a helpful tool.

Even if institutional problems are not the central issue in this quadrant, MAINTAIN Case Study No. 4 indicates with an example from the Central Valley of California that institutional aspects can still acquire a high priority in such situations. In the California case, with the mandate of the US Bureau of Reclamation changing from a service providing to a more regulatory role, difficult adjustments of the service arrangements between the water districts and their suppliers are needed to cope with such dynamics.

However, positioning of the maintenance situation in this quadrant indicates that a detailed assessment of asset condition, importance and performance might be appropriate and that it may worth the effort to establish comprehensive asset management programs as they are explained in MAINTAIN Thematic Paper No. 8.

This is why the main strategy for this quadrant can be referred to as *"Asset Management Strategies"*.

Strategy option D: Weak service arrangements – unsupportive institutional environment

This quadrant – the extreme opposite institutional environment compared to case A – represents the worst case scenario. Here neither the arrangements between the provider and the users, nor the relationships with the government or other essential supportive actors, are founded on a sufficiently solid institutional base. What can be the hope to establish a well-functioning and sustainable service delivery system for maintenance under such circumstances? Experience and common sense indicate that such hopes will remain illusions. The example of the St.Raphael Irrigation System in Haiti in the times of "Baby Doc" Duvalier (described in GTZ-publication No. 263) illustrates this point: all the

essential coordination mechanisms needed to establish a functioning water delivery and maintenance system were defunct. Endless cycles of deterioration and rehabilitation were the consequence.

What are the strategic options in such situations?

There are essentially three options:

- One option might be to search for existing coordination mechanisms in traditional small community systems. A good understanding of such mechanisms might serve as a model for such mechanisms in the context of the given irrigation scheme and then follow the "enclave approach" described in strategy option C. In the Haiti case, a thorough understanding of internal coordination mechanisms employed in traditional small irrigation schemes in hill areas of Haiti might have helped to establish functioning service arrangements in St. Raphael.
- If such models do not exist, then the major thrust of any strategy needs to be sector wide efforts for institution building, time consuming and dependant on the political environment as such efforts may be. Simply developing maintenance manuals and training people to do maintenance – an approach often pursued in such situations – will be a predictable waste of resources.
- A third option not often implemented so far is the option of temporary external management takeover by or a competent third party. In cases where the government might consider the irrigation scheme in question to be vitally important for the national economy, it might opt for such a strategy, hoping to transfer the system back to local actors, once institutional strengthening in line with the previous option has been done. In situations of institutional chaos and serious food shortages such an option may become a realistic point of discussion, in spite of all question marks that remain with respect to the feasibility of the future transfer process.

Hence, positioning in this quadrant indicates that normally any maintenance approach needs to be preceded by efforts at institution building .

This quadrant can be termed *"Sector Strategies of Institution Building"*.

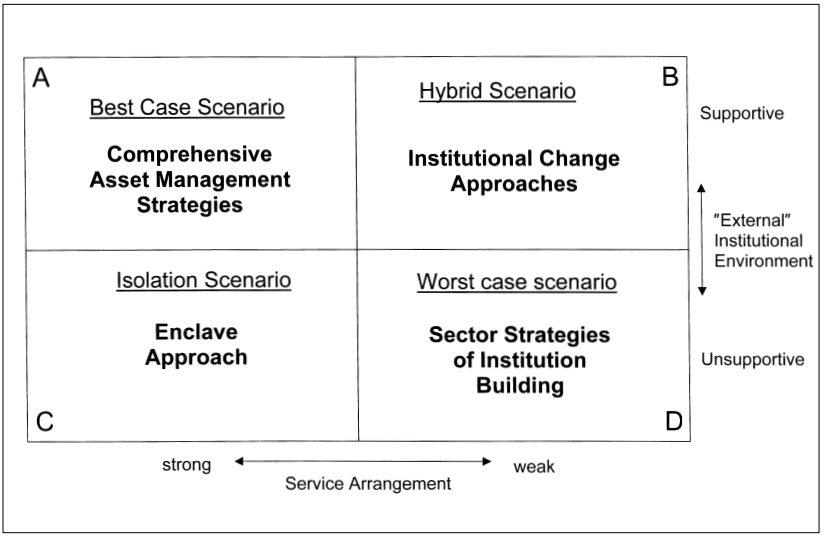


Fig. 6: Situation specific maintenance strategies in different institutional environments

Strategy option C: Strong service arrangements – unsupportive institutional environment

This quadrant represents situations that are often found in developing countries, where well functioning community irrigation systems operate in external institutional environments that are anything but supportive. Formal water laws are either nonexistent or do not consider local traditions sufficiently, the staff of government agencies are either badly trained or chronically underpaid or both, the regional and national judiciary is heavily influenced by politicians, etc. In contrast, local communities have retained strong social coherence and manage to operate their irrigation systems, including maintenance provision, in a way that

fits well with their needs and preferences. The situation of small irrigation schemes in the Vilcanota Valley in Peru, described in MAINTAIN Thematic Paper No. 11, and of the Valle Alto Irrigation Scheme in Bolivia mentioned in GTZ booklet No. 263, correspond to such circumstances.

The strategy option here is clearly to prevent the unsupportive environment to encroach on and undermine the existing local institutions. This danger, however, is prevalent wherever external donors and national or regional governments embark on the improvement of such systems. Actors external to the local irrigation scheme now tend to define the objectives to be pursued, push for modernization of such systems that may not be in line with local rules and practices, and support technical improvements. This often occurs without the slightest understanding of intricate local mechanisms of contractual governance and how these are effected by the proposed changes. Strategic orientations therefore should follow a strict service orientation, acknowledging the ownership and guidance of the local communities and being highly aware that functioning local governance mechanisms are an asset that deserve protection and strengthening.

This quadrant is termed here the *"Enclave approach"* to water delivery and maintenance.

Predominant problems in such situations may relate to conflicts among the involved parties about the appropriate level of maintenance provision (see Module 1) and problems of free-riding (see Module 8). In situations like these, maintenance efforts often do not take into account sufficiently the economic incentive situation of poor water users. Intense discussions about the different institutional contexts mentioned in Module 3 may be of help here.

Strategy option B: Weak service arrangements – supportive institutional environment

Positioning in this quadrant indicates situations where attempts are undertaken to reform service arrangements for (water delivery and) maintenance in a supportive environment of government policies, laws

and regulations. Privatization of some sort or Irrigation Management Transfer are the possibilities here. The situation of actual irrigation reforms in Turkey and Mexico and to some extend in Andhra Pradesh in India, described in MAINTAIN Case Studies No.1, 5 and 6, correspond to the situation in this quadrant. The thrust of the strategy here, where reform is backed by genuine government commitment, is directed toward the change, build-up or strengthening of arrangements for service delivery. The key challenge in this case is to bring about a genuine *service orientation*. This means, on the one hand, to transfer not only the role of the user and payer, but also much of the function of the "arranger" of water delivery and maintenance services to farmers. On the other hand, it requires a profound shift in the self-perception of the agency staff from "patron" to "service provider." Such changes imply wide ranging structural reforms and can only be brought about when the incentives for irrigation staff are such that it "pays" for them to do so (see Module No. 10 of this Guide). Hence, this quadrant represents *"Institutional Change Approaches"*.

Most of the Modules of this Guide may be of help in the situations falling into this quadrant. The core issue here relates to the available options for institutional arrangements for maintenance provision, irrigation service provision and maintenance financing (see Modules 6 and 9). The preferred arrangements will be those that allow for optimal coordination and motivation of the involved actors. To approach such arrangements, the identification of the involved actors (Module 4), an analysis of existing property rights and intended service functions (Module 5), and a sound understanding of available and functional mechanisms for coordination of service relationships (Module 6) are essential steps. Existing service relationships need to be analysed to identify potential problems of transparency and accountability that open the door to high inefficiencies in service provision (Module 7). And finally, specific efforts need to be undertaken in order

to trace incentive deficiencies related to particular actors involved in the provision process (Modules and 10).

4.2 Analysis and improvement of service arrangements

One of the major insights of the MAINTAIN project concerns the nature of service provision – it can only be understood as an *interactive processes* with a variety of contributors. *Multiple actors* have to invest money, time, physical and mental effort, attention and other suitable resources into a production process that eventually generates the desired result: provision of the maintenance service.

The interaction between particular actors can be understood in terms of an exchange relationship: a particular service may be provided in exchange for a fee or other tangible or intangible reward. For example: information may be delivered in exchange for a salary, or the service of representing a user organization at the political level may be provided in exchange for honour and recognition of the representatives.

The hypothesis of this Guide is that non-existing or deficient service arrangements are a prime cause for maintenance problems world-wide (not only in irrigation). Without functioning service arrangements, neither the *coordination* nor the *motivation* of the actors involved in maintenance provision will be possible. However, discussions and analyses of service arrangements in irrigation service provision in general, and in maintenance provision in particular, have not been part of appraisal, planning and evaluation procedures in irrigation to date.

Based on the MAINTAIN concept presented above and on the practical experiences of the MAINTAIN excercises (see MAINTAIN Case Studies), we recommend the procedure summarized in Box 2 below.

Box 2: Sequence of steps to be followed when analysing and improving service arrangements for maintenance provision:

1. Initiate discussions on "Strategic Institutional Positioning" (SIP) for the irrigation scheme in question involving the major stakeholders. Select a strategic orientation referring to the basic strategies A to D, described above.
   Depending on the chosen strategic orientation, make flexible use of the following sequence of steps:
2. Identify the major actors involved in the provision of water delivery and maintenance services (see Module 4).
3. Initiate discussions and reach agreement on level of key system parameters to be achieved with maintenance efforts (see Module 1). Depending on the selected strategy, support the discussions on objectives with an assessment of the infrastructural assets of the irrigation scheme and the related investments (see Module 2).
4. Initiate workshops with the involved stakeholders to answer the question: Who provides (or is supposed to provide) what kind of service or supporting service to whom? What returns or compensations (payments) are made for the different services? Analyse major deficiencies (see Module 4).
5. Initiate a participatory analysis of the existing property rights (see Module 5).
6. Identify and document the existing authority system which defines the roles and functions of the involved stakeholders (see Module 5).
7. Initiate workshops and discuss the question: What are the external and internal mechanisms that make sure that the provider delivers high quality service and that the client honors the service agreement and pays accordingly? Identify deficiencies and options for improvements (see Modules 6, 7 and 8).
8. In the same way as indicated for step 7, analyse the institutional arrangements for Irrigation Financing (see Module 9).
9. In the same workshops discuss the question: What are the incentives that lead the provider to deliver high quality services? What are the incentives that induce the client to engage in the exchange relationship and provide agreed-upon compensation? Identify deficiencies and options for improvements (see Module 10).

Part 2 of this guide presents the MAINTAIN Modules and gives recommendations on how to adjust the sequence of steps and the use of the MAINTAIN Modules depending on the identified strategy.

Part Two

Analysing and Improving Maintenance Provision

Table of Contents

Using the MAINTAIN-Modules to develop institutionally viable maintenance strategies and service arrangements

When we widen the perception of maintenance to include institutional issues, we are obliged to face vastly diverging institutional contexts. To respond to such diversity with attempts to look for the "one best way" to approach maintenance must be bound to fail. Hence, there is an urgent need to understand and discuss the resulting consequence that different situations require different maintenance strategies. The approach termed "Strategic Institutional Positioning", introduced in Chapter 4, can help to bring about such debates and awareness.

The package of independent Modules made available in this Guide corresponds to such an approach. Depending on the prevailing strategy option and subject to the dominant problem areas in a given situation, different Modules may be referenced.

Table M0 summarizes the possible references to various Modules when discussing the different strategy options.

Subsequent to the title of each Module, we name the major references and sources used as "Supporting Documents". Readers who are searching for detailed references and literature used should consult these documents and the section "additional references" at the end of this volume.

As stated before, the individual Modules may be used independently. However, this requires that the reader accept some redundancies that are needed to minimize cross-references.

Table M0: Applying the MAINTAIN Guide in differing contexts

Type of Situation According to Fig. 5 and 6, Chapter 4	Most Probable Problem Areas	Major Focus of Analysis	Major recommended Modules
A	Few institutional problems; technical and economic/ financial topics dominate	■ Asset Management Approaches	Module 2 (RAA) is essential, selected Modules according to needs
B	Deficient institutional arrangements for service provision	■ Analysis of coordination mechanisms ■ Accent on Principle-Agent problems ■ Analysis of incentive deficiencies ■ Analysis of institutional arrangements for financing	Main target situation of this Guide. Nearly all Modules are applicable.
C	■ Deficiencies in objective determination ■ Collective goods problem ■ Encroaching of external institutional environment on local service arrangements	■ Accent on determination of desired level of service ■ Solving of free-riding problems ■ Strengthening service orientation of official government agencies	Modul 1 (Service objectives) Modul 8 (Free-riding) General focus of Guide
D	Deficient external institutional framework (problems with irrigation service are only secondary problems)	General institutional strengthening	This Guide with focus on maintenance problems is not sufficient here. Change of focus on general support for policy and institution building required.

Module 1

Identifying service objectives and performance standards

(Supporting Documents: MAINTAIN Thematic Papers No. 5, 8 and 12)

Why is it so difficult to establish objectives and standards for maintenance provision?

As we have discussed in section 2.2 of Part One of this Guide, a core aspect of a service orientation in maintenance provision is clarity about the purpose of maintenance. After all, maintenance is not an end in itself, but is a "secondary service" to the service of irrigation water delivery. In the eyes of the farmers, maintenance efforts will only pay if they have a significant effect on the farmer's income level. However, establishing the connections between a specified level of irrigation service and the maintenance required to ensure that service is difficult. It is even more difficult, to establish the links between maintenance inputs and the resulting increments in farm income.

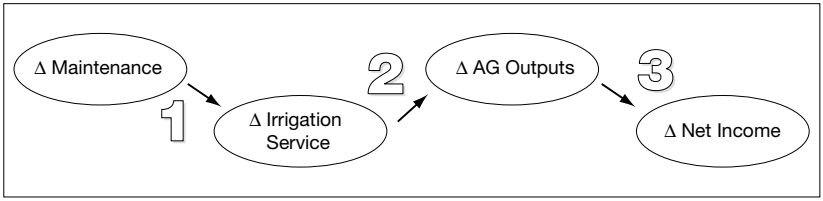


Fig. M1-1. Maintenance causality chain

To shed light on these contingencies, it is necessary to disaggregate the maintenance input/production output equation. The schematic in Figure M1-1 depicts the chain of connections between changes in maintenance input and changes in net farm income.

Relationship 1 in the figure comprises the process of transforming maintenance funding into irrigation

service. The effectiveness and efficiency with which these services are organized and provided defines the functional relationship between maintenance funding and quality of irrigation service – the bang for the buck that is provided.

Relationship 3 takes place within the farming operation. Here the farmer's management skills, along with relative prices, determine the profit he makes.

Relationship 2 is a critical one for the purposes of this Guide, for it lies at the heart of what is "optimal" in optimal maintenance. This relationship comprises the "contract" between the irrigation service provider and the clients for the service.

Such a comprehension of the causality chain related to maintenance provision highlights the difficulties encountered when trying to establish the involved connections. This explains why it is so seldom done.

The purpose of this module is to introduce the concept of "level of service" and to give guidance with respect to objective determination based on such a concept and considering different institutional contexts.

There are two other reasons for the infrequent application of clear objectives and performance standards for maintenance. First, budget constraints are notorious in maintenance provision. Hence in many circumstances, the available budget determines the maintenance program, rather than the maintenance program determining the budget. Second, the identification of the *desired level of service provision* will depend greatly on the institutional setup in which the irrigation system operates. Before we consider different institutional contexts and the resulting differences in objective definition, let us define more clearly the term *"level of service"*.

What is the "level of service"?

It is helpful to assess performance in the context of a so-called "level of service provision", both in terms of the water delivery service and in terms of the system's

maintenance. The two are interlinked – maintenance can affect water delivery and the operation of water delivery can affect maintenance. In general, a particular level of maintenance is a necessary prerequisite for the water delivery service.

The level of service is a set of predefined operational standards that describe the quality of the water delivery provided to the water users (see MAINTAIN Thematic Papers 8 and 12). When defining a level of service, the objective is to document and agree upon an official standard or norm against which the current service provision can be compared. This also provides a standard when discussing the motivation of different actors to contribute to the common objective (as will be seen below).

The level of the maintenance service in irrigation is closely linked to the level of service in water provision. Therefore the latter one needs to be well defined when discussing intended maintenance standards.

When we talk about a level of service, we need to differentiate clearly between

- The *official* level of service – the level officially stated and pursued by an irrigation organization or a water user association
- The *potential* level of service – the level which the technical system is able to provide;
- The *desired* level of service – the level of service desired by the involved stakeholders.
- The *actual* level of service – the level actually provided.

In an ideal situation the official, the desired and the actual levels of service will coincide and they all will approach the potential level fairly closely. However, in reality, it is essential to identify gaps between these levels. To be able to do this we need to consider the different types of levels separately.

The "official" level of service

To identify the officially stated level of service both for water delivery and for maintenance, one may review official policy statements and other documents and interview officials to determine the official view – both with respect to water delivery and with respect to maintenance – about the following two questions:

- What services are supposed to be provided?
- At what level or standard of service should these services be provided, according to official policy and guidelines?

Ideally, the level of *water delivery services* should be expressed in terms of criteria that are relevant to farmers such as (see *MAINTAIN Thematic Paper No. 8*. In this paper, indicators are given for these criteria.)

- Area of command
- Adequacy
- Timeliness
- Reliability
- Security
- Cost
- Convenience
- Flexibility

In an ideal case, the *level of maintenance* required will be described in a so-called "asset and performance report" that provides data on the function, performance and condition of a particular piece of irrigation system infrastructure.

While such information might be available in irrigation schemes corresponding to situation A described in chapter 4, which exist principally in industrialized countries, many schemes in developing countries have no explicit service objectives. Instead, managers – both of public and of farmer managed schemes – follow more input- or process oriented methods of performance orientation. They stick to

certain administrative quotas or standard procedures depending on the resources available.

This scenario appears to be the common situation in public irrigation sectors of developing countries that often have to be positioned in the area between quadrants B and D of figures 5 and 6 in chapter 4. But even in these situations water service objectives are stated in general policy terms at the national or state level: such as targeted command area to be irrigated, discharges of water to be delivered for certain periods at certain delivery points, or simply intentions to provide water for two crops per year, one rice crop and one non-rice crop; or to provide five irrigations per season for two seasons. These are further qualified and quantified at the scheme level. Sometimes service objectives also include water delivery for domestic needs, fisheries, and even rural industry.

The "potential" level of service

The *potential* level of service for water provision depends primarily on

- The type and design of the infrastructure
- The capability of the involved actors to manage operation and maintenance (O&M).

The potential level of service as determined by the *type and design of the infrastructure* can be assessed through engineering studies. Such studies are not the subject of this Guide. However, indicative relationships similar to those given in table M 1-1 may be used for canal systems. In this overview, different canal control and water delivery systems are graded according to their level of service potential, the respective O&M requirements and costs.

The *capability of the involved actors to manage (operation and) maintenance services* refers to their capability to take appropriate decisions with respect to

Table M1-1: Indicative relationship between level of investment, canal control, level of service and O&M requirements and costs

(Source: Burton 2000 in MAINTAIN Thematic Paper No. 8)

Type	Canal Control system	Water Delivery system	Level of service potential	O&M requirements	O&M costs	Capital investment level	Indicative O&M cost level $/ha	Possible potential income level
1	Fully automated downstream level canal control, fully adjustable and responsive to farmer demands	Demand	Very high, fully responsive to farmers demands for water. Highly efficient in water use	Low staffing levels due to automation, but work force need to be highly skilled.	Low on day-to-day basis but high over time as control equipment is expensive. High capital cost, low O&M cost.	High	30	High
2	Manual control with some automation at key locations. Discharge measurement at flow division and delivery points.	Arranged-demand	High, responsive to farmers' demands for water though farmers need to order water in advance. High interaction between service provider and farmer.	High staffing levels due to manual operation and need for measurement to match supply to demand.	High due to cost of O&M staffing and associated facilities (offices, motorbikes, etc.). Maintenance costs high to maintain and replace gates over time.	Moderatel y high	60	Good
3	Manual control throughout the system. Discharge measurement at flow division and delivery points.	Supply-demand	Moderate. Supply driven with irrigation service provider controlling/ allocating available water taking into account farmers cropping patterns. Relatively low interaction between service provider and farmer	Moderate staffing levels due to manual operation and need for some measurement to match supply to demand	Moderate due to O&M staffing and need for some O&M facilities. Maintenance costs high due to need to maintain control gates.	Moderate	40	Moderate
4	Manual control at main control points, ungated and/or proportional distribution at lower locations. Limited measurement.	Supply	Moderate, not responsive to farmers' demands, limited control over water distribution to match demands.	Moderate to low staffing levels due to manual operation, though little measurement	Moderate to low due to O&M staffing and need for some facilities. Maintenance costs moderate due to need to maintain main control gates, kept lower by low-cost control at delivery points.	Low	30	Low
5	Fixed proportional control system, supply controlled, not responsive to demand. Measurement at water source intake only.	Supply	Moderate to low, ot responsive to farmers demands for water but farmers can plan ahead and adjust cropping pattern to suit supply. Inefficient in water use.	Low level of staffing, only low skill levels required	Low due to low O&M staffing levels and to low-cost proportional division structures.	Very low	10	Sub-sistence

planning, organizing, coordinating and controlling such services and with respect to incentive provision to all those who participate. To assess such a capability requires identifying relevant stakeholders, determining the services and support services they have to provide to each other, and to examining the viability of the rules, contracts, agreements and common practices that govern such relationships. Module No. 6 of this Guide provides the basis for such assessments.

The "desired" level of service

The desired level of service corresponds to the actual "demand" of the stakeholders, especially the water users. However, the determination of this demand requires different approaches in different institutional contexts.

Problems arise in cases where there are no institutional arrangements to make sure that all stakeholders, particularly the farmers, participate in determining the desired level of provision. In such circumstances, the officially stated maintenance objective will not be identical with the level of service really desired.

The following differences in approach, referring to the different scenarios explained in chapter 4 and Figures 5 and 6 (see pages 52 and 56) are important:

Situation A – the "Best case scenario"

We recall that in situations like these, the existing service arrangements are well established and functioning and the external institutional environment is supportive of such arrangements.

It is only in conditions of Situation A – as defined in chapter 4 – that the procedures to identify objectives and standards for maintenance provision, as described below, can be followed directly. In such a context, mechanisms are in place which ensure that the major

Box M1-1. Objective determination for maintenance in a California irrigation district

The Broadview Water District is a 4,000 hectare irrigation system in California's Central Valley growing a variety of high value crops in a hot dry environment. It is governed by a board comprised of district landowners. Farmers value reliability of supply very highly in this environment, as a delay of several days in a scheduled irrigation can completely eliminate the grower's profit for the season.

When the current district manager took over several years ago, the system was seriously deteriorated. He convinced owners to impose on themselves a special maintenance fee to be used to bring the system back to the required high standards of reliability. The manager presents the board annually with a proposed budget for the coming year, and the board modifies and approves it, automatically fixing the per hectare fees they will face for the year. (After Cone, 2000 in MAINTAIN Thematic Paper No.11).

stakeholders (or their representatives) can participate in the setting of objectives and standards. In the Neste System in Southern France (MAINTAIN Case Study No. 2), this mechanisms is the "Comité Neste". In this committee, the major stakeholders decide upon service levels, tariffs, maintenance needs, and budgets. In the Broadview Water District in California (MAINTAIN Case Study No. 5), the body to take decisions on maintenance levels and budgets is the Board of Directors in which the farmers and the district management are represented and which is supported by a special maintenance committee (see Box M1-1).

In both cases the institutional conditions are such that stakeholder involvement in the objective determination is fully garanteed. Under such conditions, emphasis can be given to determining the desired level of service and to discussing performance standards as they are presented and discussed below. We refer to such approaches in the following as to the "*standard approaches"* to objective determination.

Situation C – the "Enclave Scenario"

In this situation, we have defined the maintenance strategy of the "enclave approach" (see chapter 4). This refers to farmer managed irrigation systems with a strong social coherence, where the system is functional even in an unsupportive external environment. To determine the desired level of service in such circumstances is seldom done in practice. Burton states in MAINTAIN Thematic Paper No. 8, that *"to the author's knowledge little, if any, work has been done on assessing farmers' desired level of service in smallholder irrigation schemes in developing countries"*. Instead, the desired level of maintenance service is often defined from the outside with little or no intricate knowledge as to the internal institutional arrangements that guide the decisions of the farmers.

As a consequence, this scenario requires a very careful investigation into the really desired level of service.

Box M1-2. Objective determination for maintenance in Peruvian smallholder irrigation systems

In the mid 1990s, the German Government supported a program to rehabilitate and improve more than a score of 100 to 200 hectare traditional irrigation systems in the Peruvian Andes. When the program ended in 1997, a mission was sent by the agency funding the work to evaluate the project. The mission found "serious organizational and technical deficits in the operation and maintenance of the irrigation systems as it was carried out by the water users associations." This disturbing conclusion led to the dispatch of a second mission early the following year. This second mission, including a broader set of perspectives, concluded that deficiencies existed, but that they were not hydraulically significant. They noted farmers had demonstrated the capacity to raise substantial resources to make emergency repairs, that critical problems were repaired immediately and that minor problems were ignored or delayed with good reason. This experience demonstrates the importance of stekeholder objective determination for maintenance in small scale schemes with strong social coherence as is the case in many regions of the Peruvian Andes. (After Urban, 2000 in MAINTAIN Thematic Paper No. 11.)

In doing this, some essentials of the standard approach described below may be of use. The problem here is that "demand for service" has to be understood in the sense of an "effective demand". The desired level of service does not stand for an illusory level the farmers may desire, but represents the level for which they clients are prepared to pay or make the necessary contri-butions.

In practice such an assessment may be difficult to implement. Therefore, a "Rapid Economic Assessment of Maintenance Needs" (REA) – as it is described in Module 3 of this Guide – may be implemented. We refer to approaches of objective determination in such circumstances as to the "*stakeholder objective determination*".

Situation B – The "Hybrid Scenario"

In this case, the external institutional environment appears quite supportive, but the existing service arrangements are highly ineffective for irrigation service provision.

In situations where service arrangements do not allow full and genuine stakeholder participation in the objective determination, all attempts to do this without developing or strengthening institutional arrangements will lead to doubtful results. Maintenance may be a merit service here, i.e. a service provided by the state to serve the collective well-being and supplied on the basis of its own terms and conditions. However, the official level of service defined here has nothing to do with a genuine desired level of service provision. In such cases the major focus of the objective determination should be on the *institutions* and *procedures* that lead to decision making about objectives rather than on the details of the objective determination itself.

Efforts to identify levels of service in such situations should be preceeded by or intimately linked with efforts to establish institutions and procedures that allow such a participatory identification.

To the extent that this precondition is fulfilled, some of the essentials of the standard approach to objective determination as it is presented below may be used.

We refer to this approach as the "*merit-service approach"* to objective determination.

Situation D – The "Worst Case Scenario"

In this worst case scenario of institutional contexts, there are no actors who have a legitimate basis to decide on a level of service. Questionnaires and interviews may identify a desired level of service but institutions and processes for stakeholder decision making do not exist.

Here, it will not be possible to establish an agreed upon level of service unless farreaching reforms of the overall institutional context have been brought about.

This is why we refer to this approach as to the "*institution building approach"* to objective determination.

A Standard approach	**B** Merit service approach
C Stakeholder objective determination	**D** Institution building approach

Fig. M1-2: Different approaches to objectice determination in different institutional contexts.

Essentials of the standard approach to determining the desired level of service

Determining the desired level of maintenance service requires establishing the following information:

- Identifying different potentially feasible options for the desired level of irrigation service, given the existing infrastructure
- Identifying maintenance requirements related to these levels of service, costs for the different levels of service, and the water users' ability to pay
- Identifying the changes in income levels induced by the different service levels comparing them with the respective costs.

As we have explained in the introduction to this Module, such information is not easy to provide. In fact, even in industrialized countries, this information is seldom available.

There are techniques, employed in other infrastructure sectors, for establishing such connections explicitly, but these have rarely been applied in the irrigation sector.

These techniques generally fall under the heading of "Asset Management". MAINTAIN Thematic Paper No. 8 describes these techniques and suggests ways that could be applied to irrigation system maintenance. This paper also presents a methodology for "Rapid Asset Appraisal" (RAA), an approach that is documented in Module 2 of this Guide.

However, even with the RAA methodology, the impact of the individual asset performance on the overall system performance and on the related income differential is difficult to establish. Computer-based simulation models of system operation are sometimes useful in specifying such relationships. However, such approaches may not be feasible in many circumstances even if they are positioned in basic situation A.

Depending on information needs, it may be sufficient in many cases to determine roughly the relationship between the performance of particularly important individual pieces of infrastructure and the overall system performance. *Importance* relates primarily to

Table M1-2: Possible performance, condition and importance relationships (Source: Burton and Hall 1999)

Performance	Condition	Importance	Priority	Explanation of situation	Consequence
Good	Good	High	Low	No problem with asset. Performance and condition are good, indicating that asset is new and in serviceability grade 1 or 2.	Low probability of structural failure.
Good	Good	Low	Low	No problem with asset. Performance and condition are good, indicating that asset is new and in serviceability grade 1 or 2.	Low probability of structural failure.
Good	Poor	High	High	The situation is hazardous because the asset is close to failure, but its good performance may provide a false sense of security. High priority status because of the importance rating.	High probability of sudden structural failure which could have high direct and indirect cost consequences
Good	Poor	Low	Low	The situation is hazardous because the asset is close to failure, but its good performance may provide a false sense of security. Low priority status because of the importance rating.	High probability of sudden structural failure which could have moderate direct or indirect cost consequences.
Poor	Good	High	High	High priority status as performance is low and importance is high. Condition is good indicating that performance is affected by something other than condition.	Engineering assessment required to identify the problem causing the poor performance.
Poor	Good	Low	Low	Low priority status since importance is low. Condition is good indicating that performance is affected by something other than condition.	Engineering assessment required to identify the problem causing the poor performance.
Poor	Poor	High	High	High priority status as performance and condition are poor and importance is high. This indicates that the asset has failed and is in serviceability grade 4 or 5.	High probability of sudden structural failure which could have high direct and indirect cost consequences.
Poor	Poor	Low	Low	Low priority status as importance is low. However, the poor performance and condition indicate that the asset has failed, or is about to fail, and is in serviceability grade 4 or 5.	High probability of sudden structural failure which could have moderate direct or indirect cost consequences.

the asset's function, position in the irrigation or drainage network, and its replacement value. A river diversion weir is more important than the secondary canal head regulator, for example, because of its central function in diverting and controlling inflow to the scheme, its position at the head of the system, and its (usually) significant replacement cost.

Through engineering studies, the cost database for maintaining or enhancing the condition/performance of each type of asset (river weir, canal head regulator, aqueduct, culvert, etc.) can be ascertained and applied to the asset condition/performance of each asset. In this way the cost of maintaining or enhancing the condition/performance of the irrigation and drainage system is determined. An indication of the possible relationship between the condition, performance and importance is presented in Table M1-2.

Under ideal conditions, especially in situations of the type A, studies may also identify the anticipated improvements in performance benefits arising from different levels of investment. However, in most cases, this will be neither practical nor feasible. It may then be helpful to refer to the tool of "Rapid Economic Appraisal" presented in Module 3.

Farmers' criteria

The following criteria for the water delivery service are often particularly stressed by farmers (after Burton and Hall 1999):

The criteria in the table have been ranked to emphasise the fact that farmers have different levels of priority for the various criteria, and will be prepared to forego some and not others. The ranking is scheme specific and may vary between farmers. Obtaining these rankings is not easy, but is essential if the desired level of service is to be defined.

In agency-farmer managed systems, a similar table of criteria and priorities can be constructed for the irrigation service provider. Here, the priority of the criteria may be quite different. The service provider may have to compromise output as a consequence of

Table M1-3: Possible criteria for assessing level of service provision (of irrigation water supply) from farmers' perspective
(Source: Burton and Hall, 1999)

High Priority	Moderate Priority	Low Priority
■ Command (water level)	■ Cost	■ Efficient
■ Adequacy	■ Quality	■ Equitable (Fair)
■ Timeliness	■ Convenience	■ Safety
■ Reliability	■ Flexibility	
■ Security		

limitations related to inputs (river flow pattern) and processes (control infrastructure).

In this case, the performance assessment will have to be done at three levels additional to the farmers' level mentioned before: *scheme, system and statutory*.

Scheme level relates to overall performance of the scheme and uses criteria and performance indicators that produce an overall assessment for the scheme.

System level relates to the irrigation network and uses criteria and performance indicators that relate mainly to the inputs and the processes of water conveyance. Adequacy and timeliness and command in this respect relate specifically to input (at water source) and process (throughout the network), not to output. Equity, efficiency (conveyance and pumping where used) and financial cost are key criteria at this level.

Statutory requirements are those, such as drainage outfall from irrigation schemes into rivers, which might be stipulated by law.

Table M1-4 shows a "Servicability Matrix" that may help guide the establishment of relevant criteria and for the preparation of negotiations on the *desired* level of service. A final, but extremely important criterion for

Table M1-4: Possible Irrigation Serviceability Matrix: criteria and classifications (after Burton and Hall, 1999)

	SCHEME PERFORMANCE		SYSTEM PERFORMANCE						
Grade	**Productivity**	**Cropping Intensity**	**Cost (Economic)**	**Efficiency (Resource use)**	**Adequacy and Timeliness**	**Command**	**Equity of supply**	**Efficiency**	**Cost (Financial)**
1	Greater than 90% of potential	Greater than 90% of potential	Very highly economic	Very high	Adequate and timely at all times	Target levels maintained at all times	Water distribution equitable	Efficiency levels match target values	Highly viable
2	70-89% of potential	70-89 % of potential	Highly economic	High	Generally adequate and timely	Target levels generally maintained	Distribution generally equitable	Efficiency levels generally adequate	Very viable
3	50-69 % of potential	50-69 % of potential	Moderately economic	Moderate	Adequate and timely on average	Target levels maintained on average	Distribution equitable on average	Efficiency levels adequate on average	Moderately viable
4	30-49 % of potential	30-49 % of potential	Marginally economic	Low	Frequently inadequate/untimely	Target levels frequently not maintained	Distribution frequently inequitable	Efficiency levels frequently inadequate	Low viability
5	Less than 29% of potential	Less than 29% of potential	Uneconomic	Very low	Completely inadequate/ untimely	Levels not maintained.	Water distribution is inequitable	Efficiency levels unacceptable	Not viable

	FARMERS' REQUIREMENTS						STATUTORY REQUIREMENTS	
Grade	**Adequacy and Timeliness**	**Command**	**Reliability of supply**	**Security of system**	**Water quality**	**Waterlogging and Flooding**	**Health and Safety**	**Environment**
Grade 1	Adequate and timely at all times	Target levels maintained at all times	Fully reliable of failure	No risk constraints	No	None	Complies	Complies
Grade 2	Generally adequate and timely	Target levels generally maintained	Generally reliable	Some risk of failure	Some constraint	Some incidence	Not applicable	Mild hazard
Grade 3	Adequate and t imely on average	Target levels maintained on average	Reliable on average	Moderate risk of failure	Moderate constraint	Moderate incidence levels	Not applicable	Moderate hazard
Grade 4	Frequently inadequ. and/or untimely	Target levels frequently not maintained	Frequently unreliable	High risk of failure	Serious constraint	Serious incidence levels	Not applicable	Serious hazard
Grade 5	Completely inadequate and/or untimely	Command levels not maintained.	Completely unreliable	Failed or failure imminent	Quality fatal to agricultural production	Unacceptable incidence levels	Non-Compliant	Non-Compliant

the desired level of service is the *'willingness to pay'*. This willingness depends on available incentives but above all on the economic assessement that stakeholders do with respect to different levels of service. However, as we have stated repeatedly, the link between a certain level of maintenance, the resulting effect on the water delivery service, and the ensuing incremental changes in production and income levels is extremely difficult to establish. Nevertheless, stakeholders develop perceptions of costs and benefits related to different levels of maintenance service provision. Module 3 provides some guidance on how to evaluate such assessements.

Gaps between levels of service – what do they tell us?

Assuming that the official and the desired levels of service for water delivery do not surpass the potential level of service the system can provide, then gaps between the level of service actually provided and the official and desired levels of service can be quite indicative of the problems encountered. Such a "goal incongruence" can be interpreted as shown in Table M1-5.

Table M1-5: Gaps between levels of service

Degree of goal congruence	Indication	Strategic orientation of further actions	Occurence in particular situations
Official = desired = actual l.o.s.	No O&M problems	Best practice scenario: maintain actual l.o.s.	Most probable in situations A and C described in chapter 4
Official ≠ desired = actual l.o.s.	System has adjusted to desired l.o.s.	Adjust official l.o.s. Prevent external official views to impinge on system	Frequent situation in community systems with external support (Situation C in chapter 4)
Official = desired ≠ actual l.o.s.	No problems of goal incongruence but other problems. High level of stakeholder coordination.	Maintain official l.o.s. Analyse system to identify causes for suboptimal l.o.s.	Frequent situation in community systems with internal problems (Situation C in chapter 4)
Official ≠ desired ≠ actual l.o.s.	Problems of goal incongruence plus other problems	Review of desired l.o.s. and careful analysis of the service system	Most frequent situation in developing country irrigation (Situations B, C and D in chapter 4)
Official ≠ desired l.o.s. Official = actual l.o.s.	Centrally administered system with strong management	Discuss pros and cons of system change to desired l.o.s.	Special case of 'enclave' situation (e.g. state farm) (Situation C in chapter 4)

l.o.s. = level of service

Module 2

Rapid Asset Appraisal (RAA)

(Supporting Documents: MAINTAIN Thematic Papers No. 8 and 11)

What is "Asset Management"?

The core idea behind "asset management" is the recognition that infrastructure is supposed to provide a certain service from which benefits can be derived. Canals allow the delivery of irrigation water, drains can be used to evacuate drainage water, roads serve to allow or facilitate transport and mobility. Maintaining or enhancing that service providing function results in sustained or enhanced benefits, either financial or social.

This idea has farreaching consequences: in fact, it implies that the quality of maintenance is closely related to the level of service that one intends to maintain. This is an important shift in maintenance philosophy, namely a shift from an input to an output orientation. Maintenance – not only in irrigation – traditionally has been an input oriented excercise. Maintenance staff and/or contractors used to face (and still face) a multitude of specifications on materials and procedures but are not required to guarantee the infrastructure's ability to provide the intented level of service. Maintenance manuals present prescriptions on how, when and with what means to do maintenance. However, they normally do not help to link maintenance provision to a given output level, e.g. to a predetermined "level of water delivery service" in irrigation.

Following this line of thinking, Asset Management (AM) is a structured and auditable process for planning maintenance of and investment in infrastructure to provide users with a sustainable and defined level of service.

Asset Management establishes connections between maintenance and maintenance expenditure on one hand, and asset condition and system performance on the other. It does this by establishing the following chain of connections (Box M2-1).

Box M2-1. Essential steps in Asset Management

Determing the desired level of service

↓

Determining the current extent, condition, value and performance of individual assets

↓

Relating individual asset extent and performance to system performance

↓

Determining the cost of maintaining or enhancing performance of each type of system asset

↓

This is obviously not a simple process and is very data intensive. Most applications are computer-based and generic commercial software for AM is available. Computer-based simulation models of system operation are also useful in specifying some of the relationships involved, that between individual asset performance and system performance in particular. The nearest widespread application of this approach to the irrigation sector is in public water supply systems, where it is used extensively in the UK and elsewhere.

Given these preconditions the applicability of Asset Management approaches will be limited in most cases to institutional contexts such as those described with "Situation A" ("Best Case Scenario/Asset Management Strategies") in chapter 4. However, in other situations a simplified form of Asset Management, the "Rapid Asset Appraisal", presented below, may be applied as a supporting tool.

The purpose of this Module is to introduce a procedure for Rapid Asset Appraisal. Such a procedure can help to establish basic connections between maintenance and system performance, a link that is crucial in maintenance service provision.

What information is needed for a Rapid Asset Appraisal?

In looking at maintenance of irrigation and drainage systems it is important to be aware that the condition and performance of the infrastructure is a function of its:

- Design
- Construction
- Operation
- Maintenance

The quality of the design and construction influence the rate at which the infrastructure deteriorates and how it performs its intended function. How the infrastructure is used and operated can affect its condition and performance, as can the level of maintenance.

In this Module, we do not deal with matters of design, construction and operation. In practical cases one would have to investigate whether or not and to what extent these factors influence condition and performance of the infrastructure. Here, we focus exclusively on maintenance. Design and construction do enter the framework, however, by setting a limit on the "potential level of service" discussed in module 1.

In relation to maintenance, the condition and performance of the infrastructure is influenced by the level of:

- day-to-day maintenance
- annual maintenance
- emergency maintenance
- deferred maintenance
- capital replacement.

Information on the first three components is relatively straightforward to obtain from records kept by the irrigation service provider and discussions with service provider staff. The information required relates to the expenditure, type and extent of the work carried out.

Information on deferred maintenance (which is an accumulation of failure to adequately carry out all requirements under the first three categories) is difficult to obtain, as records of total (outstanding) maintenance requirements are often not kept. Failure to carry out necessary maintenance work "mines" the asset base, resulting in system deterioration.

The final category, capital replacement, represents expenditure to replace assets as they reach the end of their useful life, or become obsolete. Failure to adequately maintain the assets during their lifetime can obviously lead to a more rapid deterioration and a reduced life expectancy. This category is often not considered in maintenance studies.

For the fourth and fifth maintenance categories identified above a detailed study is required of the asset base to assess it current condition and level of performance. During an appraisal of the institutional issues related to maintenance there is not the time to carry out a detailed study of the asset base and simplified measures have to be used.

What are the essential steps to be taken when implementing a RAA?

For RAA, data need to be collected to determine the current condition and level of performance of the infrastructure, including the following:

- the extent of the asset base
- the condition of the assets
- the performance of the assets
- the importance of individual assets

Where the asset base is maintained in a good state of repair, and assets are replaced as they reach the end of their useful life, as is the case with the Neste System in Southern France (MAINTAIN Case Study No.2), such a

study might not be required, except to establish that these conditions do prevail. In this case, the expenditures made for maintenance reflect the true cost of maintaining the system over time.

The steps required to carry out a RAA are summarised in Table M2-3 (see pages 92/93) and discussed below.

- *System overview*
  During this step the infrastructure is inspected and discussions held with farmers and service provider staff on their perception of scheme performance and levels of service provision. Note should be taken of the appearance of the crops, crop yields, marketing, soil conditions, farming practices, etc.

- *Obtain general background data*
  The next step is to obtain background information on the scheme. This will include maps and aerial photographs (if available), and records of cropping over recent years. This data will form the backbone of subsequent data collection and analysis.
  The extent and quality of the data available will provide insight into the standard of management, operation and maintenance on the scheme.

- *Obtain and process detailed system performance data*
  Detailed data are collected to enable an assessment to be made of the performance of the irrigation scheme and to identify potential areas of concern. Secondary data are required for this analysis, since there is usually not time to collect primary data.

- *Identify current and potential performance levels and current and desired levels of service provision*
  Analysis of the data will help to identify the level of performance of the scheme. Application of Module 1 of this Guide can be used to help determine the desired level of service. From the analysis of the actual performance and the system configuration, an assessment can be made of the potential

performance level, leading to identification of the gaps and current constraints to production. This analysis is a major activity. The degree to which it is carried out depends upon the context, the time available and the experience of those performing the assessment. Arising from the analysis will be a first rough assessment of current and potential performance of the scheme.

- *Obtain maintenance data*
  Information needs to be collected on the extent and type of maintenance work carried out and the expenditure on maintenance. This information is required for a period of at least 5 years, if possible, to assess trends. From analysis of the data it will be possible to form an opinion on the maintenance situation and its likely impact on the condition and performance of the infrastructure.

- *Determine extent of existing asset database, stratify and select sample base*
  The ease with which an asset database can be obtained varies from scheme to scheme. Many schemes have asset inventories and schematic diagrams that provide information on the asset base and the location of assets. Some schemes have as-built construction drawings which can prove invaluable. Having such records obviously simplifies the task of preparing an asset database. The validity of the database can be assessed during the asset survey. In large schemes, a stratification of the assets can be carried out and the number of samples sets and their size determined, making use of the database and field inspections. (For further details see Annex 1 of MAINTAIN Thematic Paper No. 8).

- *Carry out asset survey*
  To save time it will be necessary to map out the location of the assets selected for inspection and to move through the system inspecting them. In almost all cases the headworks will be a one-off assessment,

Table M2-1: Performance services of physical components of irrigation and drainage schemes

(Source : Burton 2000 in MAINTAIN Thematic Paper No. 8)

Component	Levels	Performance service
Canals	Primary Secondary Tertiary Quaternary	To convey water
Drains	Primary Secondary On-farm	To remove water from the field
River weir	Main canal	To divert and control irrigation supplies
Headworks	Main canal intake	To take in water to the main canal. This may be a group of structures, including a river weir, head regulator, settling basin, and measuring structure, or one structure such as a pump station.
Pump station	Main canal Main drain	To lift water to command level for irrigation. To remove water from drainage channels which are below river level
Settling basin	Main intake canal	To settle out sediment
Cross regulator	Primary and secondary canals	To raise and maintain water surface at design elevation
Head regulator	Primary, secondary and tertiary canals	To regulate discharge entering a canal
Measuring structure	Primary, secondary and tertiary canals	To measure discharge for operational purposes
Aqueduct	All levels of canal	To pass canal over an obstruction (another canal, a drainage channel, etc)
Culvert	All levels of canal or drain	To pass canal or drain under an obstruction (road, drainage channel, etc)
Drop structure	All levels of canal or drain	To „drop" the canal or drain bed level in a safe manner. Used to slacken canal or drain slopes on steep land
Escape structure	All levels of canals	To release water from a canal into the drainage network in the event of oversupply or under-utilisation.
Syphon underpass	All levels of canals	To pass the canal below an obstruction such as a road or drainage channel.
Distribution box	Quaternary canal	To distribute water between quaternary channels
Night storage reservoir	Main canal or on-farm	To store irrigation water during the night for release during the day. Main canals can thus operate 24 hours/day whilst lower order canals can be operated during the daytime.
Tubewell	On-farm	To abstract groundwater for irrigation. Often used in conjunction with surface water system
Bridges	Road bridges Foot bridges	To allow human and animal traffic over the canal or drain
Roads	Inspection roads Access roads	To gain access to the irrigation system and villages. For inspection and maintenance

the asset survey can start there and proceed downstream. During the asset survey it is valuable to be aware of the system as a whole and note any features/factors which might influence scheme performance.
The asset survey involves the following steps.

- *Defining the function – i.e. the infrastructure service – performed by a certain asset.*
  As an orientation, a list of performance services of different components of irrigation and drainage schemes is given in table M2-1 on the previous page (repeating table 3 in Part One of this Guide)
- *Condition grading of the asset*
  (see Annex to Module 2)
- *Performance grading of the asset*
  (see Annex to Module 2)
- *Importance grading of the asset*
  (see Annex to Module 2)

Importance relates primarily to the asset's function, position in the irrigation and drainage network, and its replacement value. A river diversion weir is more important than a secondary canal head regulator, for example, because of its central function in diverting and controlling inflow to the scheme, its position at the head of the system and its (usually) significant replacement cost.
With such information, standard proforma can be drawn up, or notes made in a notebook using a data collection checklist for each asset type. An example of a data collection proforma is given in Table M2-4 (see page 94). Examples of how to go about with asset condition/performance/importance grading are given in the Appendix to this Module.

■ *Formulate asset condition and performance report*
Once the sample sets of assets have been surveyed, the data set can be extrapolated to characterize the whole population and a picture obtained of the condition and performance of the scheme's

Table M2-2 (identical with table M1-2): Possible performance, condition and importance relationships
(Source: Burton and Hall 1999)

Performance	Condition	Importance	Priority	Explanation of situation	Consequence
Good	Good	High	Low	No problem with asset. Performance and condition are good, indicating that asset is new and in serviceability grade 1 or 2.	Low probability of structural failure.
Good	Good	Low	Low	No problem with asset. Performance and condition are good, indicating that asset is new and in serviceability grade 1 or 2.	Low probability of structural failure.
Good	Poor	High	High	The situation is hazardous because the asset is close to failure, but its good performance may provide a false sense of security. High priority status because of the importance rating.	High probability of sudden structural failure which could have high direct and indirect cost consequences
Good	Poor	Low	Low	The situation is hazardous because the asset is close to failure, but its good performance may provide a false sense of security. Low priority status because of the importance rating.	High probability of sudden structural failure which could have moderate direct or indirect cost consequences.
Poor	Good	High	High	High priority status as performance is low and importance is high. Condition is good indicating that performance is affected by something other than condition.	Engineering assessment required to identify the problem causing the poor performance.
Poor	Good	Low	Low	Low priority status since importance is low. Condition is good indicating that performance is affected by something other than condition.	Engineering assessment required to identify the problem causing the poor performance.
Poor	Poor	High	High	High priority status as performance and condition are poor and importance is high. This indicates that the asset has failed and is in serviceability grade 4 or 5.	High probability of sudden structural failure which could have high direct and indirect cost consequences.
Poor	Poor	Low	Low	Low priority status as importance is low. However, the poor performance and condition indicate that the asset has failed, or is about to fail, and is in serviceability grade 4 or 5.	High probability of sudden structural failure which could have moderate direct or indirect cost consequences.

infrastructure. In a comprehensive Asset Management appraisal, the assessment of the impact of the current condition and performance of individual assets on the overall performance of the scheme has to be made once all the data has been collected. This assessment is not easy, and some subjective judgement will be required to make the assessment. Recent studies by El-Askari (El-Askari 1999; GICC 1998) have shown the significant value of using hydraulic modelling to aid such assessment. In these studies El-Askari used hydraulic modelling to identify linkages between asset performance in one part of the irrigation system with impacts at other locations. Amongst others, the impact on downstream water delivery of sediment levels within canal sections was investigated, as was the impact on downstream water delivery of damaged or poorly maintained control structures.

In cases, where such data collection and modelling work cannot be done, it may be sufficient to establish possible performance-condition-importance relationships. Such relationships will allow establishing priorities for maintenance intervention, even if the exact impact of asset conditions on overall performance of the scheme is not known.

Repeating table M1-2, an indication of the possible relationship between the condition, performance and importance is presented in table M2-2 on page 90.

Table M2-3: Summary of steps for Rapid Asset Appraisal
(Source: Burton 2000 in MAINTAIN Thematic Paper No.8)

	Data and Details	Purpose
System overview	■ inspect canal and drainage system ■ preliminary talks with farmers and service provider staff on system management, operation and maintenance	To gain an overview and the "feel" of the irrigation and drainage system as a guide to the approach to be adopted for the asset survey. Note the general type and condition of the infrastructure, the type, condition and quality of the farming.
Obtain general background data	Background data includes: ■ maps ■ climatic data ■ scheme cropping pattern ■ average crop yields and production ■ system operation and maintenance procedures	Gain more detailed insight of the scheme, the layout, production levels, management, operation and maintenance procedures. Start to formulate initial opinion of the management, operation and maintenance, and its implications for scheme performance.
Obtain and process detailed system performance data	■ crop type, yields and production per tertiary unit ■ irrigation water supply at primary, secondary and tertiary head regulators ■ process data ready for analysis	Obtain and process data to quantify scheme performance and potential problems.
Identify current and potential performance level and current and desired level of service provision	■ analyse performance data to identify production problems: ow yields, differential production performance ■ hold discussion with farmers and service provider staff to ascertain views and perceptions on current and potential performance level and level of service provision ■ identify and quantify current level of performance and level of service provision ■ identify and quantify potential/desired level of performance and level of service provision ■ identify nature and cause of gaps and constraints ■ decide if infrastructure condition and performance may influence overall system performance	Analyse data to quantify current and potential levels of performance and current and desired level of service provision. Identify the gaps and constraints and assess the likelihood that the condition and performance of the infrastructure might be a factor.

Obtain maintenance data	■ recurrent maintenance budget and allocation ■ annual expenditure on maintenance contracts ■ annual expenditure on emergency maintenance ■ maintenance requirements ■ maintenance staff, equipment and facilities ■ form opinion on maintenance situation	Understand situation in relation to maintenance. Answer questions: Is maintenance funding high, moderate, low? Is maintenance work being deferred? Are maintenance procedures (for work identification/ prioritisation, etc) adequate? Is lack of maintenance an issue?
Determine extent of asset base, stratify and select sample base	■ obtain asset database ■ obtain design drawings (if available) ■ decide on stratification, sample sets and size ■ decide on sample sets ■ decide on normalisation measures for each sample set	Identify and categorise asset types, sizes, function etc. Prepare stratification of the system and decide on sample sets and sizes, and normalisation measures for each sample set. Preparatory work for carrying out asset surveys.
Carry out asset survey	For selected sample sets: ■ categorise and record asset condition ■ categorise and record asset performance ■ categorise and record asset importance	Obtain the fieldata for the sample sets from which to be able to formulate asset condition and performance inventory report.
Formulate asset condition and performance report	■ expand sample set data to full population (”normalisation”) ■ assess impact of infrastructure on scheme performance and level of service provision ■ finalise findings of influence of infrastructure on current system and scheme performance and level of service provision. ■ Finalise findings on gaps between current and potential scheme performance and current and desired level of service in relation to infrastructure condition and performance ■ prepare Asset Condition and Performance Report	Formulate final findings on the influence of infrastructure condition and performance on current and potential/desired scheme performance and level of service provision. Write up findings as Asset Condition and Performance Report.

Table M2-4: Example of proforma for asset survey data collection (Burton 2000)

Canal/drain name:

Chainage Start-Finish		Asset type	Facet	Condition Rating (1-5)	Performance Rating (1-5)	Importance Rating (1-5)	Discharge capacity (m3/s)	Leading dimensions				Remarks
Start (Km)	Finish (Km)							Height (m)	Width (m)	Length (m)	Other	

Survey conducted by:

Name: **Date:** **Position:**

Annex to Module 2

Differentiating between asset condition and performance

A distinction needs to be drawn between the condition of an asset and the impact that condition level has on the performance of the asset in its defined function. It is possible to find an asset, such as a cross regulator, which is in poor condition but which is still adequately performing its function. In the UK water industry it was found that money was being spent on improving the condition of assets whilst there was little visible or felt improvement in the system's performance. With limited availability of funds the focus has turned towards expenditure on assets to maintain or enhance performance leading towards maintaining or enhancing the level of service provision to the customer.

Splitting the assessment of the asset into two parts, condition and performance creates difficulties in:

- surveying of the assets
- deciding on priorities for expenditure
- deciding how performance and condition are linked.

The key to overcoming these difficulties is to be clear and explicit about the function of each asset. In the sections below the procedures are outlined for condition, performance and importance grading.

Condition grading of assets

Asset condition inventories are now becoming fairly standard in many civil engineering systems. In some cases, significant steps have been made towards standardising the condition grading. For condition grading the asset must be divided up into it main component parts, termed "facets", and the condition of each of those parts assessed separately. Thus a gated cross regulator might be divided into its upstream wingwalls, upstream base and cutoff, throat section, downstream wingwalls, downstream base and cutoff, and gate.

For condition grading two basic questions need to be borne in mind when surveying the asset:

- Is the asset safe?
- Does the asset require repair?

Much condition grading relies on visual observation, though in the U.S. Army Corps of Engineers (USACE) Directorate of Civil Engineering the condition assessment includes physical tests such as load testing. In the UK water industry a 5-point grading system has been adopted as shown in Table M2-5. In addition colour photographs illustrating the various condition grades have been used to minimise the subjectivity involved when assessing asset condition (see e.g. Glennie at al. 1991).

Performance grading of assets

Performance grading seeks to assess the degree to which the asset is able to perform its function. The

Table M2-5: Example of standardised condition grading for a concrete bridge over a canal or drain
(Source: Burton 2000 in MAINTAIN Thematic Paper No. 8)

Concrete Bridge Structures

Condition Grade	Description
1	No visible defects. No more than hairline cracks, no signs of any honeycombing or spalling.
2	Wider cracking, greater than 0.5 mm. Localised honeycombing and spalling. Concrete flaking. Signs of previous repair.
3	Rust staining. Spalling of concrete or exposure of reinforcement. Extensive or widespread honeycombing. Evidence of weathering/erosion. Surface covered in vegetation
4	Extensive/widespread concrete spalling. Extensive exposure of reinforcement and rust staining. Signs of reduced structural integrity.
5	Clear evidence of structural failure or that failure is imminent.

assessment is for the asset as a whole if it has only one major function, or for relevant aspects if it has several functions. The main questions, which need to be borne in mind when carrying out the performance survey, are:

- can the asset perform its function or performance service?
- can the asset perform to its design capacity?
- how does the performance of the asset influence system performance?

The performance grading system is similar to that for condition grading, with five grades. To focus on the functionality aspect, a Function Statement is attached to each asset that defines its function. An example of performance grading for a canal head regulator is given in Table M2-6. The performance grading must relate carefully to the Function Statement, thus for a head regulator the performance relates to the structure's ability to *control the flow* entering the canal, whether it be to the design maximum, or to zero.

A feature of performance grading of the asset is that it may require testing of the asset. Thus in the case of a head regulator the gate must be operated during the survey to see that it can pass the design discharge, or close off the supply completely. This can be in conflict with condition grading which may require the system to be drained in order to inspect parts of the asset which are normally submerged.

Importance grading

The importance of an asset is a measure of its strategic importance to the overall functioning of the irrigation system. Influencing factors include:

- function
- area served downstream
- area affected or influenced by structure
- cost of replacing the structure
- number of people affected by structure
- danger to health and safety of asset failure
- impact on scheme performance

Table M2-6: Example of standardised performance grading for a canal head regulator
(Source: Burton 2000 in MAINTAIN Thematic Paper No.8)

Canal head regulator

Statement of Function or Performance Service	To control and regulate water entering a canal from designmaximum discharge to zero flow.
Performance Grade	**Description**
1	The structure can pass the design maximum flow, and can be shut completely to pass zero flow. There is no seepage around or under the structure into the canal.
2	The structure has restrictions on its ability to pass the design maximum flow, cannot be shut completely, and/or there is seepage around or under the structure into the canal. Canal discharge is limited to 80 % of design, or the discharge entering the canal cannot be reduced below 20 % of design.
3	The structure has significant restrictions on its ability to pass the design maximum flow, cannot be shut completely, or there is significant seepage around or under the structure into the canal. Canal discharge is limited to 60 % of design, or the discharge entering the canal cannot be reduced below 40 % of design.
4	The structure has severe restrictions on its ability to pass the design maximum flow, cannot be shut completely, or there is severe seepage around or under the structure into the canal. Canal discharge is limited to less than 40 % of design, or the discharge entering the canal cannot be reduced below 60 % of design.
5	There is no control of discharge through, around or under the structure. Discharge entering the canal may be zero or greater than 100 % of design.

There is no consensus yet as to a standardised approach to classification of importance. Based on the work of Cornish and Skutsch (1997) and IIS (1995) the following algorithm is proposed to develop an Importance grading for an asset:

Importance grading = $(a_i/A) \times FI$

Where:

a_i is the area influenced by the asset. Bridges, roads, escape structures, etc, are assigned a service area equal to that of the canal reach on which they occur

A is the total command area of the irrigation scheme

FI is the Function Index taken from Table M2-7

The classification of Table M2-7 is somewhat subjective, for a given scheme or schemes it may be adjusted to suit. Note that a_i relates to the area influenced by an asset, thus a cross regulator and a head regulator at a secondary canal division point will have the same importance grading as they both influence the same total command area.

Table M2-7: Asset Function Index for determination of importance grading for irrigation and drainage infrastructure
(after Cornish and Skutsch 1997)

Function Index(classes)				
5	4	3	2	1
Diversion weir	Scour sluice	Canal reach	Drain reach	Inspection road
Embankment dam	Cross drainage culvert	Head regulator	Drop/chute	Bridge
Intake works	Aqueduct	Cross regulator	Side weir	
Pump station	Syphon	Measuring structure	Tail escape	
Barrage	Sediment trap			

Module 3

Rapid Assessment of Economic Incentives for Maintenance (REA)

(Supporting Document: MAINTAIN Thematic Paper No. 11)

Why do we need a "Rapid Economic Assessment" (REA) of Maintenance Needs?

When talking about incentives, we generally differentiate between material and immaterial incentives. With respect to maintenance, individual farmers may feel strong obligations toward the community or group to contribute their share and hence gain much of their motivation through immaterial – in this case socially-based – incentives. However the individual farmer, as well as a community group or an irrigation agency, will all base their decision to devote time and inputs to maintenance activities predominantly on some kind of economic calculation, asking the question whether or not the maintenance exercise will be "worth the effort".[2]

To find out in detail whether this is the case or not, each actor or group of actors will have to examine both the costs incurred by contributing inputs to maintenance, and the benefit stream resulting from such contributions. On the one hand this requires assessing maintenance needs on the basis of intended levels of irrigation service (see MAINTAIN Module No. 1). On the other hand it demands knowledge about the benefit stream generated by the irrigation service provided and the impact that different levels of maintenance have on that benefit stream. We have pointed this out repeatedly before.

A classic economic analysis would look at the relationship between incremental expenditures on

2 Economists would tend to interpret even a socially-based decision as an economic one. They would argue that the farmer would consider the costs incurred in case of non-participation. Such costs may come about as social sanctions, as costs of not being able to claim social solidarity in the future, as psychological costs of losing social standing etc.

system maintenance and incremental units of agricultural output. Nominally, expenditure on maintenance would be increased until its cost was just equal to the value of an additional unit of output. However, such a relationship involves extremely difficult-to-measure variables, substantial time lags, and a great many intervening variables. Moreover, the nature of the relationship may change over time. All of these factors mean that, in practice, even in large scale systems, such a traditional economic treatment is seldom a realistic option to assess and decide upon maintenance needs.

What other economic assessment can the involved actors undertake that may support decision making with respect to maintenance efforts? We believe that all the contributing actors can do – and in reality are doing – a "rapid economic assessment" of maintenance needs. Such an assessment hence substitutes for a full fledged economic assessment that in most cases will be too sophisticated to be implemented in practice.

The purpose of this Module is to introduce the basic philosophy behind such a "rapid economic assessment of maintenance needs". Doing so, the Module intends to draw attention to basic benefit-cost considerations that are done by different actors and that create the economic incentives to embark or not to embark upon intensive maintenance efforts.

What is the rationale behind the Rapid Economic Assessment (REA) of maintenance needs?

The REA proposed here starts from the premise that every actor potentially involved in maintenance – i.e. every organization, group or individual – will do a rough benefit-cost calculation on his/her own.

On the *cost side*, an actor will consider the opportunity cost of maintenance inputs or necessary contributions, i.e. the benefits forgone by spending time and inputs for maintenance activities. This is an important consideration for everyone: for farmers during labor intensive periods of the vegetative cycle; for farmers that have other activities apart from irrigation; for part-time farmers; for maintenance staff

who may use the time for activities that are more glamorous; for managers of irrigation agencies who may tend to devote more time and scarce funds to activities that are more visible and politically rewarding. All of these actors may have different perceptions of the dimension of the opportunity costs incurred, but all of them *will have* such a perception.

They also will have a perception as to the *benefits* of their own inputs or contributions to maintenance. And these benefits will accrue differently to different actors. Moreover, we have discussed in chapter 2.3 of this Guide that maintenance is a typcal "future good", since benefits of maintenance accrue in a sometimes distant future. Consequently many actors will heavily discount such benefits, especially poor farmers that have to struggle for survival. The focus therefore will not be so much on the benefits of maintenance but instead on the *risks* or the *potential losses* brought about by *not doing* maintenance. The different perceptions of the risk of deficient maintenance or of outright neglect together with the perceptions of the opportunity cost of necessary maintenance inputs therefore determine the economic incentives of actors to contribute heavily, only slightly, or not at all to maintenance efforts.

As to the risks involved in not doing maintenance, Levine (MAINTAIN Thematic Paper No.11) comes up with an interesting argument. He contends that because systems are usually designed with excess conveyance capacity, and because more effective system management can compensate for some degree of system deterioration, that loss of system benefits lags deterioration by a significant number of years. This certainly will help to lower the perception of risks considerably and thus favour the neglect of maintenance efforts.

Moreover, from the point of view of local decision makers there may even be a certain risk involved in *doing* maintenance. Rehabilitation financing is generally available from national budgets or international lenders and donors on concessional

terms, while maintenance has to be financed from local funds. Hence there is the risk that, in doing maintenance, one may forego the external rehabilitation funds. Consequently, a cyclic pattern of minimal maintenance and controlled deterioration, followed by externally-financed[3] rehabilitation, is a logical and effective strategy to follow.

How to go about a Rapid Economic Assessment of maintenance needs?

REA tries to assess the economic incentives of different actors – either by guessing, questioning or in the process of workshop discussions – by ordering these incentives into four major clusters. These clusters are formed by a matrix in which the perceived opportunity costs of the inputs needed for maintenance comprise one axis and the perceived risks to deficient maintenance are shown on the other. An assessment of these factors will lead to a positioning in one of the four quadrants, represented in Fig. M3-1 on page 106.

Quadrant 1, in which the perceived opportunity cost of maintenance inputs is high, but the perceived risk of consequences to limited maintenance is low, represents the assessment of farmers in many circumstances, particularly in low-income developing countries. In such cases, farmers are likely growing small grains, e.g. rice, maize, wheat, partly for own consumption and partly for sale. Market value of these crops is relatively low, and at moderate input levels, they are only moderately sensitive to water stress. At the same time, resources for all expentitures are generally scarce, particularly for farmers who have to tend to other farming activities apart from irrigation.

The situation in Quadrant 1 also reflects a common perception of agency staff with respect to maintenance. In most circumstances, staff members cannot be held accountable for maintenance deficiencies, and normally no premiums are paid for good maintenance service. Moreover, since budget allocations to the agency are not tied to the quality of service to the water users, from

3 External to the irrigation system.

their point of view the risks related to poor maintenance are low. Moreover, they may have other more attractive activities to do – design work for construction, for example – so that perceived opportunity costs of spending time on maintenance activities are high. No wonder then, that these actors will perceive few economic incentives to engage for maintenance. They will tend to just do the minimum only or neglect maintenance altogether.

In Quadrant 2, both the opportunity cost of inputs and the risks related to system non-performance are high. This is a situation which, when we look from the point of view of the farmers, is more likely to be found in middle and higher income countries, where higher value crops are cultivated under high-input regimes, and production is almost entirely market-oriented. Expectations related to benefits from good system performance are likely higher than in Quadrant 1. This leads to higher incentives to ensure reasonable system maintenance. However, since opportunity costs are high – e.g. through attractive off-farm employment – efforts will generally be targeted on insuring a high standard of reliability for critical system facilities only.

From the point of view of agency staff members, Quadrant 2 may correspond to the maintenance of critical pieces of infrastructure. Critical infrastructure, in case of failure, may cause serious damage, loss of income or even life and thus would clearly rebound to the maintenance staff. This generally is the case with dam structures or with major structures of the main conveyance system. This is why, despite high opportunity costs for maintenance inputs, agency staff may perceive sufficient incentives to engage in preventive maintenance efforts related to these structures.

In Quadrant 3, the actors perceive low risks as well as low opportunity costs. For the farmers such a situation may arise during periods of low agricultural activities or in circumstances when maintenance works are heavily subsidized. Substantial contributions of

external funds may provide economic incentives to farmers to embark on maintenance activities which they would otherwise neglect.

Similar circumstances may hold for the staff of irrigation agencies. In cases where maintenance jobs are the only employment possibilities at hand, workers may tend even to maintenance activities that have only little or no influence on system performance, e.g. painting rails, cutting grass at the side of access roads etc.

In Quadrant 4, the risks related to incidents of system non-performance are high, while opportunity costs of providing maintenance are low.

From the farmers point of view this may be the case in high-commercial farming, where even small failures or interruptions of the intended service level can cause large losses of income. This may, for example, be the case in modern green house farming. Moreover, if labor costs for maintenance are cheap, for example due to ready availability of migrant labor, the option of "maximum maintenance" may be the appropriate one.

From the view point of agency staff, such a situation might arise in circumstances where the staff is responsible for maintenance in a high commercial irrigation environment – as e.g. in the Central Valley in California (see MAINTAIN Case Study No. 4). Here, high expenditure for maintenance may be seen as proof of the importance of the maintenance service and even help to expand staff numbers. Hence opportunity cost – in the eyes of the staff members – may be extremely low. No wonder then, that in such circumstances a tendency to do "gold plated" maintenance may prevail.

The important fact to keep in mind when going about a REA, is that this is not an *objective* economic assessment but an exercise that tries to assertain the *subjective* perceptions of particular actors. These are perceptions, however, that form the basis for actual behavior. This means that different actors may have completely different perceptions about economic incentives to do maintenance. Even when the top

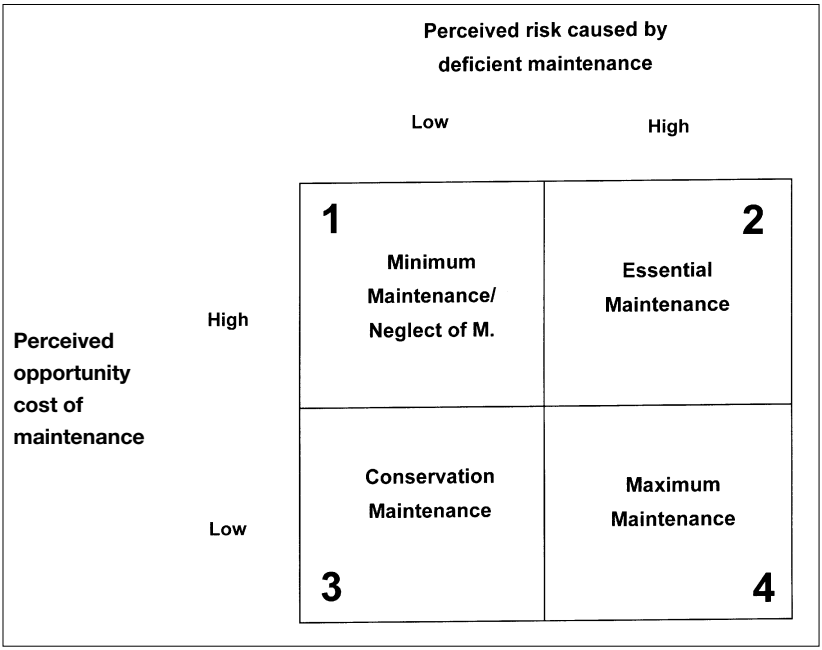


Fig. M3-1: Matrix for Rapid Economic Assessment of maintenance needs

management of an irrigation agency tries to quantify "objectively" the risks involved in deficient maintenance and attempts to assess the opportunity costs involved when doing maintenance, farmers, agency staff or other actors may perceive the situation in a completely different manner. An analysis of actor specific incentives may further clarify why such deviations come about (see Module 10).

Module 4

"Service Interaction Analysis" (SIA)

(Supporting Documents: MAINTAIN Case studies No. 1 to 6; MAINTAIN Thematic Paper No. 7, 10 and 11 and GTZ publication No. 263)

Throughout this Guide, the term *provision* or *service provision* refers not only to primary irrigation services such as water conveyance and delivery and secondary services such as maintenance. It also refers to "supporting services" such as information and administrative services, coordination and representation.

To analyse the provision of all primary, secondary and supporting services in a service delivery system means to find answers to the following questions:

- What are the primary, secondary and supporting services provided?
- Who are the "consumers" or beneficiaries of these services?
- Who are the providers of these services?
- Who are those who pay for these services or in some other way provide a "return"?
- Who arranges for and monitors the delivery (or "production") of these services, and what are these arrangements?
- What arrangements are made for the financing of service provision?

This Module provides a practical way for how to answer the first four of these questions. Answers to the fifth question are addressed in Module 5, answers to the last question are found in Module 9. This Module 4 may be useful in all of the basic institutional contexts described in chapter 4. However, it will be particulary helpful in situation B, where "Institutional Change Approaches" are pursued.

What is SIA and what is its purpose?

Answers to the first four of the above questions seem to be obvious in some cases. However, answers are difficult to find when service provision involves many different actors (a network of stakeholders) and when various supporting services are needed to make the provision of primary and secondary services functional. This is the case in most processes of maintenance provision: the provision may be arranged, paid for, used and provided by different actors and it may require a range of supporting services, such as provision of inputs, information, monitoring and auditing services, official representation of interests (viz., of farmers, et. al.), etc. In such a complex web of relations, "Service Interaction Analysis" (SIA) can quickly bring about transparency. SIA is a set of tools designed to help identify systematically the services that are being or should be provided. The tools can also make it easier to analyse the problems associated with the provision of services in a way that takes into account the distinguishing features of services.

For example, SIA can serve as an instrument to clarify mutual expectations of the provider and the client in the provision process. As such it will be a first step in tailoring mutual agreements or contracts with respect to the details and conditions of the provision of services in question.

How to organize a SIA?

Below, we present a sequence of steps that can be followed when performing a SIA exercise. However, this sequence can be handled with flexibility, depending on the particular problems at hand.

The SIA might be applied in settings in which the primary or supporting services are vague and not well defined and where the service interactions between different actors are unclear or problematic.

The SIA can be targeted at the maintenance situation of the whole irrigation scheme or at the maintenance provision of a particular section of the hydraulic infrastructure (see the discussion below on the so-called "hydro-institutional service chain"). In many

cases it might be advisable to perform a SIA exercise both for the primary service of water delivery *and* the secondary service of maintenance provision.

The ideal way to apply the SIA is within a *workshop situation* in which the most important role players participate. The central problem to be addressed by the workshop has to be identified beforehand together with the initiators of the workshop. This discussion generally reveals who the respective participants should be.

In full, the SIA can embrace the following steps:

- Identify and visualize the tapestry of relations and the "hydro-institutional service chain" (see below);
- Identify the major services or support services, that each of the involved organizations or units, i.e. each "actor", is supposed to provide to the other actors. To do this, establish a "Service Interaction Program" (see below);
- Discuss major problem areas;
- Choose one particular organization or unit as the focal point of a more in-depth analysis and then, related to this organization/unit answer the following questions:
  - What is the range of services to be provided by this actor and *to whom* are these services supposed to be provided? (i.e., the "Service Provision Program" of the actor in question),
  - What is the range of services supposed to be received by this actor and *by whom* are these services supposed to be provided? ("Service Reception Program" of the actor in question);
- Analyse the strengths and weaknesses of these provision and reception programs, including to identify gaps between actual and intended provisions;
- If needed, analyse and assess in the same way the internal interactions within the focal organization, perceiving each internal unit of this organization as the provider and receiver of certain internal services.

In the following we give short outlines to each of these steps.

Identifying the tapestry of actors and the "Hydro-Institutional Service Chain"

The first step aims to render transparent the complex tapestry of relations that exists between organizations working within a service network. For a specific service or support service, such as water delivery or maintenance, all the major stakeholders are to be identified. In other words, all the actors that are involved in any of the functions of providing, arranging, paying for, regulating, monitoring, providing support for a particular service are identified and listed.

Table 3 in chapter 2.4 indicates how numerous the interrelated actors in the field of maintenance can be. It lists all the different organizations, entities and groups with whom the Nienburg/Weser Maintenance Association in Germany has working relationships in order to accomplish its purposes.

Before carrying out this part of the SIA one needs to be clear about the scope of the exercise. Do we want to analyse service interactions throughout the whole system or should we rather focus on parts of the system only? This question may be answered more readily after drawing up a so-called "hydro-institutional service chain." With such a service chain one follows the flow path of the water from the source or the storage facility to the water delivery at the farm gates. Along this path the service chain identifies the parts of the system that provide different supporting services, that require different maintenance efforts and that involve a different set of actors. Table M4-1 shows the example of a hydro-institutional service chain as it corresponds to water conveyance and delivery as well as to maintenance in the Neste System in Southern France. This system is described in detail in MAINTAIN Case Study No. 2. The table also indicates the major actors involved.

Once the scope of the exercise is clear, it often helps in a workshop setting to draw a sketch of the "service network" that will be analysed more in detail. This initial step of the SIA helps to draw the attention of workshop

Table M4-1: Example of a Hydro-Institutional Service Chain
(The Neste System in Southern France, described in MAINTAIN Case Study 2)

Infrastructure	Services provided	Providers of the services	Arrangers, payers, users and regulators of services
Storage dams in the Pyrenees ⇩	■ Water storage and power generation ■ Maintenance of dams and power generation	■ "Electricité de France" (EdF) with private contractors	■ State, EdF, irrigators, public and private users of electricity
Neste Canal ⇩	■ Water conveyance and supply to 17 small rivers and streams ■ Maintaining all infra-structure in the Neste canal system	■ Compagnie d' Aménagement des Coteaux de Gascogne (CACG)	■ State, Public, CACG
Small rivers and streams ⇩	■ Ensuring minimum flow rates in rivers and streams	■ CACG	■ Agence de l'eau ■ Public ■ Ecology ■ Specific users (e.g.fisheries)
	■ Supplying specific amounts of water into the water courses	■ CACG	■ Irrigators in concession perimeters ■ Water user associations ■ Domestic water supply companies and villages ■ Comité Neste ■ State entity DDAF as »police de l'eau«
	■ Maintaining river banks	■ Littoral landowners	■ Littoral landowners ■ State entity DDAF as »police de l'eau«
Franchise Irrigation Perimeters ("périmètres en concession")	■ Providing set quantities of water to the franchise perimeters (FP's) during a ten year period with one year extensions ■ Maintain the hydraulic infrastructure of the FP's	■ CACG	■ Individual farmers in the systems ■ Comité Neste ■ State (DDAF) ■ Conseil Administratif

participants to the complex web of relations that exists and that needs to function in order to render the intended service provision effective. In most circumstances it is sufficient to draw a rough sketch of the service network and not indicate each and every interface.

An important point here is the fact that a service network can also be drawn up for relations between departments, divisions and other entities *within* an organization. In this case, one assumes that good functioning of the organization requires effective internal relationships that may be thought of as internal service exchanges.

Figure M4-1 shows the set of actors involved in provision of maintenance services for the primary and secondary canal infrastructure of the "Lower Seyhan Irrigation Scheme" in Turkey.

Establishing a matrix of service relations

A second and often quite helpful step in a SIA exercise is the elaboration of a matrix of service relations. The procedure is simple when representatives of the various stakeholders are present in the workshop. Each group of stakeholders is asked to define

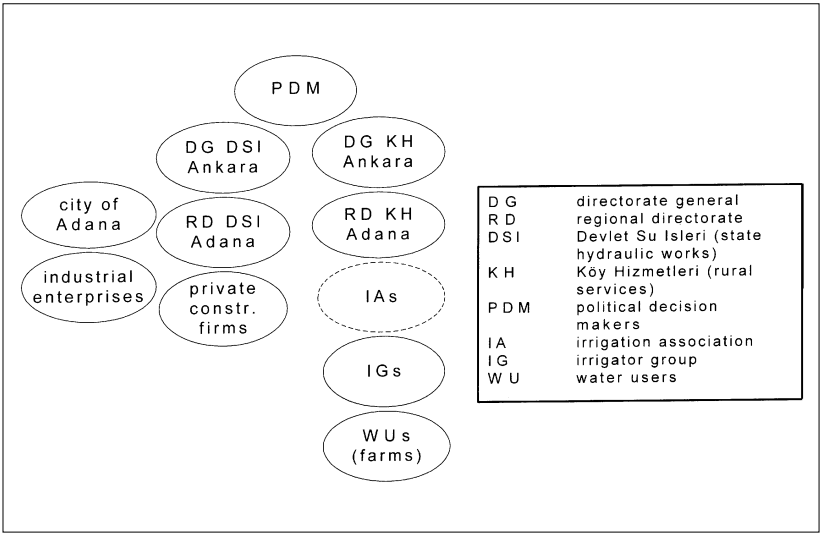


Figure M4-1: Field of actors involved in maintenance service provision – Lower Seyhan Irrigation Scheme, Turkey (Source: Scheumann and Vallentin, 1999 in MAINTAIN Case Study No.1)

a small number of the most important services that they are *supposed* to provide to anyone of the other groups.

This exercise results in a matrix where every stakeholder group is listed in a horizontal row and in a vertical column. Such a matrix allows a quick overview of the most important services and the interdependencies within the service network. The matrix shows the services to be provided from one stakeholder group (listed in the row) to another group (listed in the column). Normally, representatives of the recipients of these services will be present in the SIA workshop. This enables participants to identify deficiencies in the actual provision of services.

Defining the range of services provided by a particular entity or organization

One of the central activities of the SIA is to make an overview of the entire range of services provided by one of the organizations or entities identified above. This illustrates the full breadth of the services provided by this actor. To this end a list is drawn up of all the services provided by the organization and of the recipients of these services. The list is then broken down and categorized by type of service and recipient. This tends to reveal a number of services that would otherwise often be glossed over because of their intangible nature. These can be coordination inputs (liaising, clarifying legal issues, etc.), information services (providing specific data, advisory services, etc.) or others. The listing of the whole range of services also reveals the entire spectrum of recipients of services – in other words: exchange partners – who have relations to the organization in question.

Table M4-2 gives an overview over the services provided by German Maintenance Associations .

Defining the range of services provided to a particular entity or organization

An important step in a SIA exercise is the identification of all supporting services provided *to* a particular organization. Here again, experience shows that normally there is a larger number of services supplied by various providers than was expected by participants before the exercise started. One needs to

Table M4-2: Range of services provided by German Maintenance Associations in general and the Nienburg Association in particular.

(Source: Huppert and Urban,1998 in GTZ publication No. 263)

Service provided to →	Members	Nonmembers		
Type of service ↓		**Permit-issuing authorities**	**Other institutions**	**Social environment**
1. Active maintenance services	■ Clearance ■ Repair ■ Maintenance			■ Ecology (clearance, repair, maintenance)
2. Internal services	■ Planning/ engineering services ■ Internal administration services ■ Administration of membership fees ■ Updating records of land use			
3. Coordination services	■ Internal information	■ External coordination (obtaining necessary permits)	■ External coordination (liaising and coordinating with other bodies) ■ Clarifying legal issues and cases	
4. Information Services	■ Information events			■ Trade fairs/ exhibitions ■ Information events

be aware that deficiencies in any of these service relationships may be a cause for sub-optimal performance of the overall service provision.

As an example, the maintenance of a drainage canal system may be obstructed because some littoral farms inhibit maintenance works. Also, they do not provide

Table M4-3: Range of services provided to German Maintenance Associations in general and to the Nienburg/Weser Association in particular (Source: Huppert and Urban, 1996)

Provider of services →	Members	District association	Umbrella association	Other providers										
Type of service ↓				Authorities	Private enterprises	Independent conservation associations	Farmers' Association	"Obstruc-tors"	Consultant/ Authorities	Banks	Neighbour Associa-tions	Holder of water rights	Communities	Regional and national authorities (railways, post officce, etc.)
Services in the strict sense	Fees and other financial services	- Engineering services (technical/ economic/ ecological) - Force account work	Consultancy services*	Subsidies	- Enginee-ring services - Mainte-nance services	Consultancy services*		Difficulty in contri-butions	Consul-tancy	Financial services		Financial services		
Organiza-tional services	Informa-tion services	Information services PR services			Informa-tion services	Information services		Informa-tion services	Information services					
Coordination services	Obligation to tolerate*	Administra-tive services		- Authoriza-tions - Permits - Support for obligatory measures										
Represen-tation services		Represanta-tion of intrests	Representa-tion of intrests											

* Denotes problems areas.

the responsible maintenance provider with information about specific problems they face with the maintenance program. Unless the relationship with these actors can be made functional, such "obstructors" can seriously hinder the overall program.

Table. M4-3 demonstrates the large number of relationships that must be managed by German Maintenance Associations.

Analysing strengths and weaknesses of service provision

Analysis of the strengths and weaknesses in service provision programs enables the identification of problems or difficult operations among the large number of supporting services.

To assess the quality of the services provided, workshop participants are asked to rank the services listed on a scale from 1 to 5, from very weak to very strong. Experiences with SIA show that ranking tasks makes decision makers more aware of the so-called "soft" services, such as provision of data and other information, maintenance of informal communication channels, marketing activities and so on.

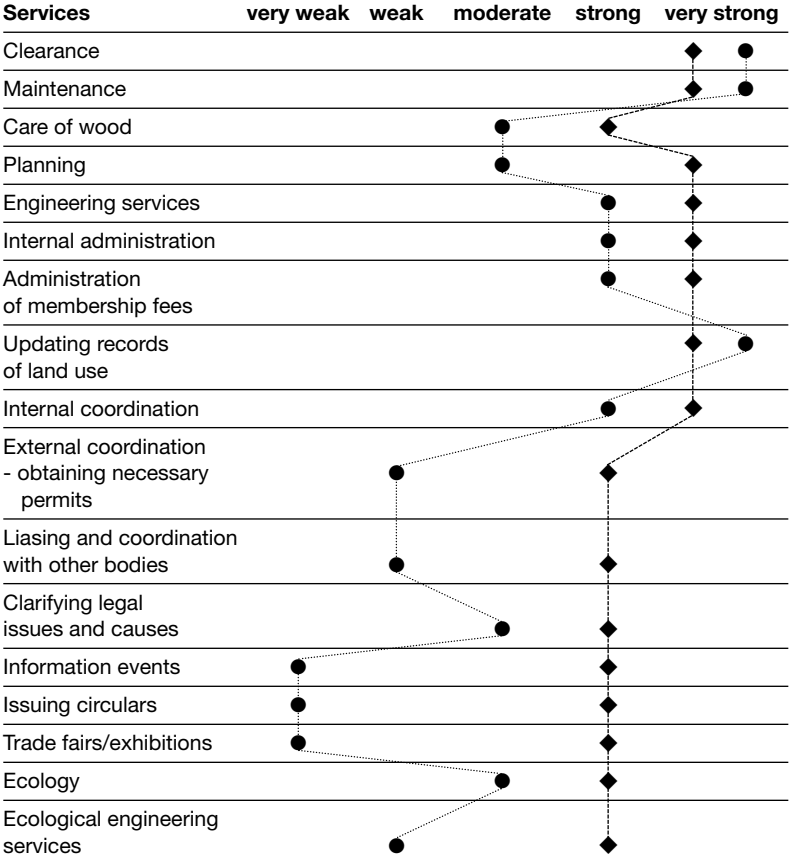
Figure M4-2 presents the results of a workshop, where participants were asked to assess the strengths and weaknesses of services provided by a particular organization (The Nienburg Maintenance Association) and the strengths and weaknesses of services provided by the entire water infrastructure maintenance subsector (the German Maintenance Associations).

Analysing problems with service interaction

Services or supporting services that have been ranked unsatisfactory in the before mentioned exercise are further scrutinized. Now, the special nature of services must be taken into account. Various kinds of services, especially the so-called "interpersonal services" such as consultancies, can only be provided in close collaboration with clients. This means that the problem of providing services must be seen not only from the viewpoint of the provider, but also from the viewpoint of the recipient and at the interface between the two sides where the interaction takes place. Thus,

Figure M4-2: Services provided by the Nienburg/Weser Maintenance Association: Analysis of strengths and weaknesses.

(Source: Huppert and Urban, 1998)



Note: ● Associations in general.
◆ Nienburg Association.

an analysis of service interactions has to look at potential problems identified at three separate levels:

- Problems involved in providing the services,
- Problems involved in receiving the services,
- Problems during the interaction between provider and recipient.

Module 5

Analysis of Property Rights and Authority Systems

(Supporting Documents: MAINTAIN Thematic Papers No. 6 and 10).

Why are property rights and the authority to perform service functions important topics in the context of maintenance service provision?

In Chapter 2.4 of Part One of this Guide we have seen that processes of infrastructure service provision require certain functions to be assumed by the involved actors: these are the functions of *arranging* the service, *providing* the service, *paying* for the service and *consuming or using* it.

Property rights and authority systems define who is entitled or obligated to assume these various functions. Hence, they establish the *roles* of the actors in exchange relationships. They constitute the backbone of service relationships in irrigation service provision, since they define who is entitled or not entitled to act in a certain way, who can reap benefits, and who must bear costs that result from the exchange. Beyond conveying authority and assigning responsibilities, however, property rights and authority delegation also play a vital role in creating incentives for the various actors to perform particular actions. Hence, to trace strengths and deficiencies in the system of property rights and functional authority means at the same time to explore incentive deficiencies in the provision system at hand.

The purpose of this Module is to give practical advice on how to detect deficiencies in property rights systems and authority systems for service functions related to infrastructure service provision in irrigation (with particular emphasis on maintenance). This Module is especially relevant for institutional contexts of type B, as defined in Chapter 4 of this Guide. Here, institutional change processes need to be initiated. Such change processes often involve changes in property rights and authority systems.

What are property rights?

Property rights to assets or resources can be defined as "the capacity to call upon the collective to stand behind one's claim to a benefit stream" that results from the use of these very assets or resources (Broomley, 1991, cited in MAINTAIN Thematic Paper No. 6). In most cases in industrialized societies, the institution backing the claim is the state (or statutory) legal system. However, this is not the only source of property rights, especially in the case of water and irrigation system assets. In addition to statutory law, most societies have devised varying forms of rights and rules pertaining to the use of water. Local norms and accepted practices may differ from statutory law, while irrigation project regulations may provide yet another basis for property rights. Thus, customary and religious institutions, local society, or even irrigation projects may be the backing institution. These different sources of rights may be contradictory, adding to the complexity of property rights, but also allowing for dynamic change.

The above definition of property rights implies that all property rights involve relationships among people – the holder of the right, those who recognize that right, and those who are backing that right. The reciprocal side of a property right is generally some form of duty in the context of the provision of the resource. An analysis of property rights therefore needs to assess the rights and duties involved, as well as the relationships between the concerned actors.

What are authority systems?

Authority systems determine the roles and functions of actors in contexts where multiple stakeholders interact. They are often based on property rights: those who control the assets or resources hold the authority. However, many authority systems are not based on property rights but on some other form of entitlement (e.g. an appointment, law, contract, tradition, or election).

In service provision, authority systems define the authority to perform certain functions in the delivery process, i.e. to arrange, provide, consume, and pay for

Table M5-1: Authority system for Andhra Pradesh irrigation management reforms
(Source: Svendsen and Huppert, 2000 in MAINTAIN Case Study No.5)

Actor	Existence by Authority of:	Authority to:	Basis of Authority
ICADD	GOAP	■ Allocate in-state surface water ■ Operate and maintain dams and other major structures ■ Plan and implement irrigation system rehabilitation programs ■ Assume control of farmer organizations (FO) in event of failure to perform ■ Allocate interstate water	■ Indian Constitution ■ AP Constitution ■ AP statutes ■ Farmer Mgt of Irrigation Systems Act of 1997 (FMISA) ■ Krishna Water Disputes Tribunal Award of 1973
Farmer Organizations/ Managing Committees	GOAP	■ Function as body corporate ■ Plan and implement water distribution ■ Plan and implement maintenance ■ Maintain landholder register ■ Prepare and maintain inventory of system facilities ■ Resolve disputes among water users ■ Levy and collect irrigation fees and other revenues and maintain accounts ■ Levy fines for infractions ■ Issue instructions to CADD Competent Authority for certain O&M activities ■ Conduct general body meetings ■ Elect officers of higher level FOs	■ FMISA ■ Changes in Revenue Code
Farmer Members of WUA General Body	GOAP	■ Elect WUA president and managing committee reps ■ Recall and replace WUA president and managing committee reps	■ Land ownership or tenancy agreement ■ FMISA
District Collectors	GOAP	■ Delineate water user areas ■ Establish WUAs and higher level FOs with compulsory membership of landholders ■ Organize and oversee FO elections ■ Collect irrigation fees	■ FMISA ■ GOAP Statute
Courts	GOAP	■ Enforce irrigation-related fines and penalties	■ AP Constitution ■ FMISA
Chartered Accountants	GOAP	■ Audit FO accounts	■ Statute
Central Water Commission	GOI	■ Regulate dam safety	■ GOI Statute

AP = Andhra Pradesh; CADD = Command Area Development Department
GOAP = Government of Andhra Pradesh; GOI = Government of India

the service and to establish relationships.These relationships may be those linking the actors who perform these functions.They may also be those between these actors and the people or bodies who stand behind the various claims. Authority systems define both the actors that hold the authority to perform a certain service function and the institutions that are the basis of that authority.

Table 5-1 shows an example for an authority system. It depicts a sketch of the authority system that is relevant for actual irrigation management reforms in Andhra Pradesh, India (see MAINTAIN Case Study No.5).

What are different types of property rights to assets and resources and different authority bases for service functions?

Schlager and Ostrom (1992 cited in MAINTAIN Thematic Paper No. 6) disaggregate the bundles of *property rights* into:

- *use rights*, including *access* (to enter the resource domain, e.g. the right to cross a piece of land, go into a forest or canal) and *withdrawal* (to remove something, e.g. to take water, fodder, or fish); and
- *control rights*, including *management* (to modify or transform the resource, e.g. by planting trees or shrubs, enlarging a canal, or restricting what can be harvested), *exclusion* (to determine who else may use the resource), and *alienation* (to transfer rights to others, either by inheritance, sale, or gift).

A more in-depth discussion on the different types of property rights is presented by Meinzen-Dick, 2000, in MAINTAIN Thematic Paper No. 6.

When we discuss the authority bases for the performance of service functions, we need to remind ourselves of the different functions that have to be performed in service provision. These are the above mentioned functions (see chapter 2.4):

- arrange the service
- pay for the service
- consume/use the service
- provide the service

Table M5-2: Categories of rights, duties and service functions

Type of property right/duty	Detailed rights/duties related to assets/resources	Type of service function	Detailed type of authority/duty to perform certain functions in the service delivery process
Use rights	■ Access rights ■ Withdrawal rights ■ Right to derive benefits from the resource	**Consumer function**	■ Authority/entitlement to enter the service provision process ■ Right to derive benefits from the service provision ("consumer function")
Control rights (1)	■ Right to "manage" the resource (modify, transform, change the resource) ■ Right to exclusion (determine who may use the resource)	**Arranging function**	■ Authority to assume the "arranging function" for service delivery (determine type of service, select provider, assign service contract, monitor provision)
Control rights (2) = Transfer rights	■ Right to alienate the resource (transfer rights to others)	**Providing function**	■ Duty to perform the service provision
Compen-sation duty	■ Duty to compensate/ pay for transfer of rights	**Payment function**	■ Duty to compensate/ pay for service provision

Table M5-2 lists in detail the different types of property rights and the corresponding functions and roles in service provision.

What are potential deficiencies of property rights and of authority systems?

Analysing systems of property rights and authority systems, one needs to check the occurence of the following potential deficiencies:

(a) The required rights/authorities are non-existent

(b) The required rights/authorities are insufficiently specified or formalized and are not transparent to all the involved stakeholders

(c) There are specific insecurities of tenure related to the required right/authority, e.g.

(c1) Non-excludability of other claimants

(c2) The duration of the right/authority is too limited to create real incentives for the right/authority holders to embark on effective and efficient resource use or performance of service functions

(c3) The "assurance" of the rights/authorities is too low, i.e. the enforcability is too weak and hence the degree to which the right can be defended is too low.

Deficiencies like these may be due to insufficient coordination mechanisms (see Module 6) i.e. insufficiently specified contracts, agreements, processes etc. and/or to deficiencies of the institutional framework.

What are important steps of an analysis of property rights and authority systems for maintenance service provision in irrigation ?

The following steps are essential:

Step1:

"Unbundle" the infrastructure services relevant under the circumstances in question (to do this refer to chapter 2.1 and to Module No. 4 of this Guide) and determine what assets/resources and what services have to be looked at.

Normally the following assets/resources and the following related services will need to be considered:

Assets/Resources

- Infrastructure, i.e. specific infrastructural elements (e.g. dams, main system, secondary system, tertiary and quarternary system)
- Water
- Ancillary resources, i.e.land, trees, fish etc.; (maintenance deficits may have consequences for rights to land, trees and other resources, though these interdependencies are seldom considered at present)

Infrastructure services

- Provision of the infrastructure
- Maintenance as a secondary service to infrastructure provision
- Services of
  – water acquisition

- water conveyance
- water distribution
- water delivery

■ Maintenance as a secondary service to water acquisition, conveyance, distribution and delivery

Step 2:

With reference to Table M5-2 above, determine who holds what type of property right

a) in relation to the infrastructural assets

b) in relation to the water resource

Now check on potential deficiencies, using the above list.

Step 3:

Determine the essential actors involved in the service delivery system.

Fill in a table, corresponding to Table M5-1 identifying for every actor

■ which authority stands behind the existence of this unit ("Existence by authority of…")

■ the respective roles and functions ("Authority to…")

■ the institutions that back up these roles and functions ("Basis of Authority")

Now check on potential deficiencies, using the above mentioned list a-c.

Step 4:

Organize working sessions to discuss the consequences of the identified deficiencies on the incentives of the involved actors. Discuss potential remedies for these deficiencies. Envisage overall system changes, in case such remedies cannot be found.

Module 6

Analysing and Improving the Governance of Maintenance Provision

(Supporting Documents: MAINTAIN Thematic Papers No.7 and 10; MAINTAIN Case Studies No. 1 to 7; and accompanying GTZ publication No.263)

Every type of human interaction can be described as an explicit and/or implicit contractual relationship. The provisions of the contract specify the mutual claims and obligations in a relationship that must be, in the end, beneficial to both parties. If the process of fulfilling these claims and obligations is designed in a verifiable and enforceable manner, – in other words, if transparency and accountability are ensured – both parties will contribute and receive whatever it takes to make the joint business a success. The means to achieve this are appropriate *"governance modes"* and *"coordination mechanisms"*.

The purpose of this Module is to present and discuss various governance modes and coordination mechanisms that may be relevant in maintenance provision. Moreover the Module introduces essential steps of a governance analysis of service provision. The final section describes situation specific approaches to solving governance problems of maintenance provision.

What are "governance modes" and "coordination mechanisms"?

"Governance modes" or *"governance regimes"* are thought of here as the overarching institutional arrangements in which a particular contractual arrangement is embedded. For example, a contractual relationship may be established in the context of a *market system* as is the case when irrigation maintenance is contracted out to a private firm. Or it may be designed on the basis of *hierarchical governance modes*, e.g. when an irrigation organization

Table M6-1: Major Governance Modes and Coordination Mechanisms

Governance Mode	Coordination Mechanisms	Enforcing Institutions
■ Market	Prices, agreements, contracts but also: ■ laws, regulations ■ common practices	Courts / legal system, state (police) but also: ■ Producer / consumer associations, unions, etc.
■ Administrative System/ Hierarchy/Bureaucracy	Internal rules and regulations, employee contracts, plans, directives, control but also: ■ laws ■ external audits, decisions of supervisory boards / committees, etc.	■ "Superior" ■ Top Managment ■ Supervisory Board ■ Courts / legal system
■ Collective decision making based on elections/ representations	■ Membership, voting, nomination, representation, formally adopted rules and regulations but also: ■ Solidarity	■ Sanctioning power of official organs (board, general assembly etc.) ■ Courts / legal system
■ Collective decision making in primary groups	■ Trust, reciprocity, solidarity, but also: ■ personal influence (based on resources, power) ■ customs / tradition etc.	■ Collective/group
■ Collective bargaining	■ Negotiations, agreements but also: ■ external arbiter	■ Public opinion (e.g. media, etc.)
■ Charity Sytems	■ Donations, raised funds, but also: ■ Preconditions, qualification systems	■ Monitoring by donor

delegates maintenance responsibilities to a special maintenance department within the same organization. Or it may be arranged within the framework of a *system of mutual help and reciprocity*, as is the case in many farmer managed irrigation systems. Table M6-1 lists a number of major governance modes.

"Coordination mechanisms" – also termed "*contractual governance*" or simply "*service agreements*" – are the particular agreements, rules, contracts, regulations and common practices that make a service relationship function. Coordination mechanisms are embedded in overarching governance modes. Hence different governance modes allow for a range of particular coordination mechanisms, as is indicated in Table M6-1. For example, in a market relationship, the price may be an important mechanism that helps govern the relationship. In a hierarchy, plans, programs and directives are dominant mechanisms. Table M6-1 lists some of the common coordination mechanisms, the governance modes they are related to, and institutions that may help enforce compliance with the agreed upon terms of the service relationship.

Institutional arrangements for maintenance provision

As we have said: governance modes and coordination mechanisms are the "backbone" of institutional arrangements for provision systems of any kind. In practical cases, often several of the above listed governance modes combine to form the institutional arrangement for the provision in question.

When a group of labourers provides maintenance to a private entity, e.g. a private irrigating farm (corresponding to the middle left quadrant in Table M6-2 below), two governance modes have to function. First, a private contract needs to be concluded between the group and the private farmer. Here, the governance mode of the *market* will play a role. Second, the group itself needs to establish internal rules and agreements as to the respective rights and obligations of each group member and how to share the work and the resulting benefit. Here, the governance mode *of collective*

decision making in a small group (a "primary group") is essential. Coordination of the provision process will only be effective if both of these modes function without problems.

Another example: If maintenance is provided by a government entity to a water user association on the basis of "government vending" (lower left quadrant in Table M6-2 below), then three major governance modes are involved. First, the internal *collective decision making* of the association has to function in order to be able to specify the terms of the vending arrangement with the government. Second, internal decision making within the *hierarchy* of the government entity needs to be effective to ensure maintenance provision and compliance with the contract. And third, the governance mode of the *market* plays a role since it will be market conditions that determine the terms and conditions of the vending contract.

Maintenance can be provided by private, collective or governmental entities as a secondary service to the

Table M6-2: Institutional Arrangements for Maintenance Provision

Maintenance provided \ Infrastructure Service Provided	privatly	collectively	by government
privatly	■ Market provision of maintenance to private user	■ Market provision of maintenance to collective entity	■ Market provison of maintenance to government
collectively	■ Collective contract for maintenance provision to private user ■ Neighbourhood help	■ Internal maintenance provision by WUA	■ Collective contract for maintenance provision to government
by goverment	■ Government management ■ Government vending	■ Free government provision of maintenance ■ Government vending	■ Internal maintenance provision by government agency

infrastructure services described in Chapter 2.1 (infrastructure provision and water delivery). Such a provision can take place in the form of different institutional arrangements. Major arrangements of this kind are listed in Table M6-2.

When we enter into the details of such institutional arrangements, we will see that in many cases they involve an even more sophisticated structure of governance modes and coordination mechanisms. In order to deal with such complex structures, it is helpful to visualize the whole provision system in the form of special flow diagrams.

Visualizing the governance of service relationships

This Guide uses a way of graphical presentation that has been applied throughout the MAINTAIN Case Studies. Following the approach of Herder-Dorneich (1986), these graphs indicate the following details (see Figure M6-1 on page 132):

- The actors concerned (organizations, groups and individuals) are presented as circles or ovals (sometimes also as squares, see example below).
- Services and supporting services are symbolized by an arrow, with a letter that indicates the kind of service in question
- Returns, especially financial returns, are also indicated by an arrow in the direction of the flow of finances
- Coordination mechanisms between two actors, i.e. the way in which service provision is governed, is depicted using a straight line plus a rhomboid shape containing either a number that is explained in the text or letters that represent the mechanism.

Fig. M6-1 shows a typical flow-diagram that presents such details for water delivery and maintenance services provided by the French "Compagnie d'Aménagement des Coteaux de Gascogne" (CACG) to so-called "franchise perimeters" in the region of the River Neste. This service system and its major coordination mechanisms are described in Box M6-1.

Box M6-1: Services, returns and coordination mechanisms – the example of franchise perimeters in Southern France.

The "Compagnie d'Amenagement des Coteaux de Gascogne" (CACG) is commissioned by the state to establish and operate the so-called "franchise perimeters" for irrigation ("périmètres en concession"). These perimeters cover some 70,000 ha and constitute the main part of the irrigation areas managed by CACG. The franchise covers a 10-year mandate to operate and maintain the irrigation infrastructure. After this period, the water users can decide whether or not they decide to extend the contract or vote for its closure.

The service to the water users consists of providing water at previously agreed flow rates and pressure to the field hydrants of individual water users. Thus, the CACG is responsible for operating all system components right through to the individual point of withdrawal and also for any maintenance and repair work. These services are secondary services to the primary service of water delivery to the farmers and are summarised and indicated by the arrow S1 in figure M6-1.

These services are financed by the contractually agreed fees irrigating farmers pay the CACG. This return to the service provision is shown in figure M6-1 as the arrow f1. These fees cover the entire service package and are made up of a basic rate of French Franks 2000/l/sec and a per cubic-meter price of FF 30. The water duty that has to be surrendered to the water agency constitutes a transitory item and is forwarded by the CACG to the water agency. This flow of funds is indicated by the arrow f3. Specific repair works may be contracted out by CACG to private companies who provide these works as a service to CACG. These services are represented by the arrow S2 and the payment by f2.

The major coordination mechanisms that make these exchange relationships function are the following:

- A key coordination mechanism is to be seen in the franchise that the state has granted to the CACG. In Figure M6-1, this mechanism is marked as CM "concession".
- A franchise agreement regulates the individual rights and duties of the CACG whilst a "Conseil Administratif", an administrative council ensures its correct interpretation and implementation. This mechanism appears as "CM CA" in the figure.
- Water provision itself is agreed with each individual farmer separately within the framework of a contract. This "contrat de fourniture d'eau d'irrigation" is indicated by CM1.
- The water users are members of formal or informal associations that are respresented in the Neste Commission (CN). In this way they have the possibility to discuss and negotiate general issues concerning the perimeter with the CACG. This coordination mechanism is shown as CB ("collective bargaining").
- In the case of these perimeters, the function of "police d'eau" – enforcing rules and applying sanctions with respect to water quotas – has been transferred by the state to the CACG. CACG executes this role via state certified experts ("agents assermentés"). This mechanism is named CM "water police" in Figure M6-1.
- The state pays certain premiums to farmers to encourage the use of water saving equipment. The rules and preconditions for these premiums are laid down in the "Politique Agricole Commune". This is indicated by CM PAC.
- The relationships with contractors are governed by commercial contracts, represented by CM2 in the figure.

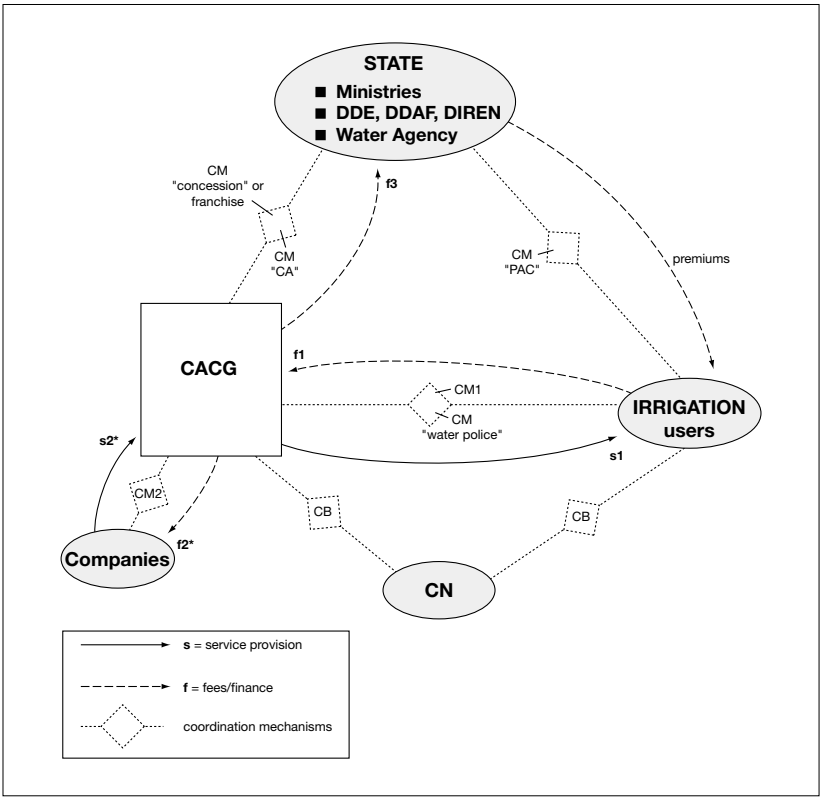


Fig. M6-1: Key services and service relations in the "périmètres en concession", i.e. irrigation franchise schemes in the Neste System, Southern France (Source: Huppert and Hagen, 1999 in MAINTAIN Case Study No. 2)

Implementing a Governance Analysis of Service Provision

The main three questions to be answered when analysing the governance of a service delivery system are the following:

- Who provides which service(s) to whom?
  - Which services are being provided or are supposed to be provided?
  - Who has the authority to arrange these services?

  - Who is providing these services?
  - Who is receiving them and using/consuming them?
- What is being provided in return for each service? From whom and to whom is this return/payment provided?
- What are the coordination mechanisms and what are the enforcing institutions that are making sure that these services and returns are actually being provided in a way that suits those concerned? In other words: what are the means available to service providers to influence the recipients or, conversely, the means available to the recipients to influence the providers when it comes to upholding their respective commitments and obligations? What induces them not to behave in an opportunistic manner?

Unless the answers to the first two questions can be given without further analysis, they may be found with the help of the above Modules 4 and 5, i.e. with the implementation of the excercises of a "Service Interaction Analysis" (SIA) and of an "Analysis of Property Rights and Authority Systems".

A "Governance Analysis of Service Provision" in general and a "Governance Analysis of Maintenance Provision" in particular may roughly proceed in the following sequence:

Step 1: Elaborate a flow-diagram of the essential services

Based on the discussion of the "Hydro-Institutional Service Chain" (see Module 4) the major actors are identified that are involved in the provision problem at hand. A flow-diagram of the essential exchanges is developed, using the symbols described above.

Step 2: Incorporate the flows of the returns (finance, fees, compensations)

The respective payments or compensations for the different services are discussed and incorporated into

the flow diagram (see Figure M6-1). An important point here is to be aware of whether or not a closed feed-back loop exists between the services provided – e.g. water delivery and maintenance – and the payments or compensations for these services. Unless an external funding source is available that provides financial resources on a longterm and reliable basis, which in most cases can no longer be assumed in irrigation, these feed-back loops between services and returns must be closed if sustainable service provision is to be achieved. In fact, such a closed feed-back loop can be seen as a coordination mechanism in its own right: a direct link between the service provision, and its quality, and the fees or prices paid for it. It is an important way to give leverage to the client and to provide incentives to those who deliver the serves.

This is why institutional arrangements for irrigation financing are discussed in more depth in Module 9.

Step 3: Discuss and visualize the respective coordination mechanisms

Discuss with the relevant representatives of the provider and the "client" the following questions:

- Who or what is making sure that the indicated services and returns are actually provided in a way that is in line with the agreement between those parties? In other words: What kind of coordination mechanisms are on hand for service delivery?
- To what extent can the service providers influence the recipients or, conversely, the recipients the service providers, when it comes to upholding their respective commitments and obligations?

The respective mechanism is then indicated with a number or a letter in the "diamond" shape of the sketch that is shown between the provider and the recipient.

Simple as this excercise may appear, the experience of MAINTAIN has shown that the basic questions asked in the course of this step are seldom asked in practice.

Hence, in many of the MAINTAIN Case Studies it was found that coordination mechanisms were either deficient or did not exist at all.

Step 4: Analyse prevailing problems with coordination mechanisms

Uncovering the problems related to coordination mechanisms in a workshop setting – so goes the experience gained in the course of MAINTAIN – normally is an easy excercise if both the provider and the client of a particular exchange relationship are involved in the discussions. Both sides are the "experts" when it comes to analysing the other side's failures and neglect.
The questions to be asked are simple:

- Can the existing coordination mechanisms make sure that the provider sticks to the service agreement and provides high quality service? What can the recipient do, in case the provider tends to behave opportunistically?
- Can the existing coordination mechanism ensure that the recipient honours the service agreement and provides timely and sufficient returns for the delivered service? What can the provider do, in case this is not so?
- Are the existing service relationship and the coordination mechanism(s) such that they convey incentives to the provider to deliver high quality services?
- Are the existing service relationship and the coordination mechanism(s) such that they convey incentives to the recipient to engage in the service relationship?

(to answer the last two questions, reference may be made to Module 10). If there are no clear and positive answers to these questions, coordination mechanisms are too weak or non-existant. When remedies to coordination problems are discussed, the following situation specific considerations deserve attention.

Toward situation specific solutions to governance problems in maintenance provision

Approaches to solve coordination problems will have a different focus, depending of the overall institutional context. With reference to Chapter 4 and to Figures 5 and 6, we describe the major thrust of such situation specific approches as follows (see Figure M6-2).

Situation A:"Refining complete contracting"

In situation A, we deal with well-established institutional arrangements and with an institutional framework that is supportive to these arrangements. Ideally, there should be no governance problems. However, in reality, steps 1 to 4 of the above analysis may reveal governance deficiencies.

We refer here mainly to conditions in industrialized countries. In such contexts, data availability, technical know how and institutional capacities are such that in most cases detailed "asset management" approaches to maintenance (see Module 2) will be feasible. These approaches make available detailed quantitative information concerning the technical requirements, the necessary standards, the timing and the cost of the enviseaged maintenance program. Hence, on the basis of this information, it will be possible to specify clearly which services and returns have to be provided at what point in time. These specifications can be clear enough to be objectively verifiable *ex post* by third parties. In such cases we speak of *"complete contracting"*: the level and the quality of the maintenance service as well as the price are unambiguously defined.[4]

Governance deficiencies in these situations will normally refer to insufficient specification of these supposedly "complete" contracts. Solutions will hence try to improve the terms of contract for the maintenance provision, possibly by improving the database through better asset management approaches. This is why we speak in this case of *"refining complete contracting"*.

4 For more details on types of contracting see supporting document MAINTAIN Thematic Paper No. 10

Situations B and D: "Coping with incomplete contracting"

In situations B and D, as they are defined in Chapter 4 and Figure M6-2, institutional arrangements for maintenance provision are weak or non-functional. Normally, this will mean that asset management approaches are not a realistic option here. As a consequence, the maintenance services that have to be provided over a longer period of time cannot be described in an exhaustive manner in advance. Also, since institutional arrangements are still evolving, maintenance objectives may change over time. In order to allow the involved parties to react to such changes in a mutually beneficial way, contracts between them have to be appropriately flexible. At the same time, the contracts should not be open to opportunistic exploitation by either party. MAINTAIN Thematic Paper No. 10 discusses a range of contractual provisions that allow coping with such uncertain contract conditions. The major provisions of this sort are:

- *A third party as arbiter*
  The service provider and the client can agree to use an arbiter in the event of a dispute. The decision of the arbiter has to be honoured by both parties. Otherwise, specified sanctions will be applied. These sanctions must also be part of the contract. Establishing or appointing an arbiter is particularly useful in environments where unambiguous laws are not existing, or where neutral law enforcement cannot be taken for granted.
- *Unilateral decision making authority*
  Here, the client side pays a premium to decide at a given point in time whether or not the contract will be executed or extended. For example, an irrigation organization or a water user association may award a longer-term maintenance contract to a private company (the longer term being the "premium" paid) but retain the unilateral right to cancel or to extend the contract after a fixed time period. This provides

Box M6-2: Using external arbiters in maintenance management

In Pakistani irrigation schemes farmers had been expressing concerns about the quality and quantity of the maintenance that had been provided by contractors on behalf of the Provincial Irrigation and Drainage Authority (PIDA). In 1997, the government decided to involve a few reputed firms to monitor the maintenance work. These arbiters discovered that weaknesses in the contracting procedures of PIDA were causing the maintenance deficiencies. PIDA officers had specified the terms of contract fairly rigorously – trying to establish _complete' contractual arrangements – and had left little flexibility for the contractors to adjust to unforeseen circumstances. Given the high negotiation costs for the contractors, the small quantity of work per contract, and the fear of loss of business, the contractors followed instructions closely, even in situations where this proved to be technologically inadequate (from UL Hassan in MAINTAIN Country Paper No.2).

incentives for the firm to deliver a good and reliable service – even if not all the details of this service have been specified in advance – hoping that the contract may be extended.

- *Standards*
  Given the difficulties in setting up a detailed asset management plan, an irrigation organization or a water user association may decide to set a standard with respect to the level of the water delivery service. Decisions on the details of maintenance provisions are left to the contractor. As long as the predetermined level of water delivery service is assured, the contract is fulfilled. Proven underachievement will be penalized by certain reductions in the returns for the service in question. However, the setting of standards alone is an ambiguous approach with respect to maintenance. The effects of neglected maintenance often appear only in a distant future. Hence, the contractor may use this fact to his/her advantage and reap the benefits of the contract while at the same time underinvesting in actual maintenance provision. This is why this approach normally should not be a "stand alone" solution.

- *Earmarking of maintenance expenditures*
  In situations B and D, it will often be difficult to plan the necessary annual maintenance activities in advance. In context B, where the institutional framework is supportive, the service provider can be obliged by external institutions (e.g. the government) to be prepared for unforeseen events and provide sufficient maintenance. To achieve this, the state may require that a "maintenance reserve" is earmarked in the annual budget of the provider. This reserve is designed high enough to cover the costs of the work likely to be necessary and cannot be used for other purposes. The state may stipulate an upper and a lower limit each year for the maintenance of medium and large-scale irrigation schemes. This will rule out any excessive preventive maintenance whilst also ensuring that larger maintenance jobs are not put off for years to come.
  The example of such a maintenance reserve is presented and discussed in MAINTAIN Case Study No. 2, referring to water management systems in Southern France.
- *"Agreement to agree"*
  In situations of insufficient information about future events and related maintenance and repair

Box M6-3: "Agreement to agree" arrangements in Andean irrigation schemes

"Agreement to agree" contractual arrangements for maintenance and especially for repair can be found in many farmer managed irrigatiuon systems. This often escapes the notices of outsiders. In many Andean irrigation systems, for example, there are implicit 'agreement to agree' rules with respect to unforeseen upcoming maintenance and repair needs. Irrigation farmers in the Bolivian Andes, for instance, adhere to the principle of 'ad-hoc working groups'. To cater to changing and unpredictable repair requirements, the irrigation farmers keep advance planning to a minimum but maintain a common understanding (an 'implicit contract') to form ad-hoc working groups, whenever need arises.

requirements, a useful contractual provision may be the so-called "agreements to agree". In such cases, the respective parties arrive at an agreement – possibly documented in a contract – that requires to reach an agreement within a given period of time after the needed information becomes available. Otherwise, specified sanctions will be applied.

- *"Shot-gun clauses"*
  In its simplest form, this is a coordination mechanism reminiscent of the distribution rule "one person slices the cake, but the other can choose which slice he or she wants first". Such an arrangement provides strong incentives to the party responsible for setting up the distribution to strive for the most equitable way to do so, since otherwise the rule "backfires" against the decision-maker himself.

The examples of special contractual arrangements given above illustrate *how to cope with "incomplete" contractual rules*. Using such mechanisms, the parties can ensure that agreements are honoured and that opportunistic behaviour is prevented, even in an uncertain institutional environment. With these and similar mechanisms it may be possible to establish governance for maintenance provision which is independent of legal enforcement. Thus, such mechanisms are likely to work even in countries without a "functioning" (in a western sense) judiciary, as will be the case in situations of type C and D.

Situations of type C:"Strengthening solidarity"

Here we refer to type C situations, as described in Chapter 4 and in Figure M6-2. In irrigation, these are functioning farmer managed irrigation systems. Very small systems of this kind will be subject to the governance mode of "collective decision making in primary groups" as mentioned in Table M6-1 above. In systems like these, there is strong social cohesion based on local customs and traditions. Hence, trust, reciprocity

and solidarity play leading roles as governance mechanisms.

The paradox we find here in relation to our discussion on governance is the fact that many of the previously mentioned contractual mechanisms can be completely counterproductive in this situation. Normally in this context the actors are farmers who have supported each other for generations on the basis of customary "implicit contracts" of mutual help and reciprocity. A sudden switch to formal, and possibly even written, contracts may seriously erode mutual trust and solidarity. Therefore, the challenge in such situations is to reinforce existing institutional arrangements and traditional governance systems.

The important point here is, that the erosion of trust and solidarity mechanisms must be perceived as a very high cost related to maintenance provision. This is why there is ample evidence that many farmer managed systems prefer to have some hydraulic structures built such that they require frequent rebuilding or

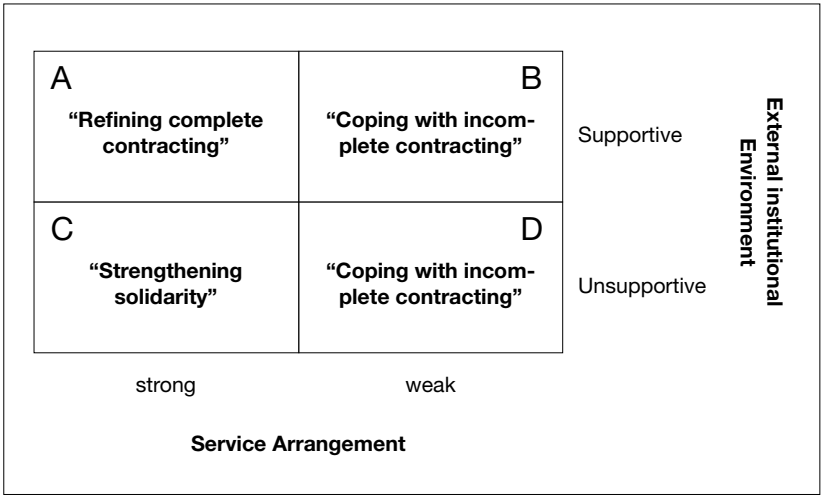


Figure M6-2: Situation specific solutions to governing maintenance provision

rehabilitation. Temporary stone weirs and groynes that are washed away with peak runoff of the rivers and have to be rebuilt annually are a case in point. The joint effort of the community for reconstruction contributes to strengthen solidarity among the community members. The high costs of repeated investment of time and labour are balanced by the benefits of community solidarity.

This comes down to the requirement to study carefully the existing governance mechanisms in situations of type C, so as to devise approaches to maintenance that *strengthen solidarity mechanisms* instead of eroding them.

Module 7

Analysis of "Principal-Agent" problems

(Supporting Documents: MAINTAIN Thematic Paper No.10 and MAINTAIN Case Study No.3).

What are "Principle-Agent" problems?

Principle-Agent problems are deficiencies related to contracts and agreements between exchange partners, in our case between the provider and the client of a service relationship. In another terminology, as we used it before, such problems are particular deficiencies of "coordination mechanisms". Problems of this kind are due to the fact that the provider side has more information about the service provision process than does the client side. Such a so-called "information asymmetry" is, on the one hand, both necessary and desirable since it reflects the division of labour and the specialisation of the provider. On the other hand, though, the actor who is not as well informed, the "principal" (in our case the client of the service delivery) runs the risk of being exploited by the better informed party, the "agent" – the service provider.

Why is the analysis of Principle-Agent problems important in the context of maintenance service provision?

Maintenance is a typical "future good" (see Chapter 2.3 in Part One of this Guide). This means to say that the benefits of maintenance normally accrue in a more distant future. When, for example, the irrigation agency or farmers do regular preventive maintenance at a check-structure and intake sluice, the benefit is that they avoid deterioration or possible failure of these structures *some years from now*. This characteristic of maintenance makes it difficult for those who commision maintenance services, the principals, to receive immediate proof that the service has been done according to agreement unless they invest heavily in monitoring efforts. On the other hand, those who provide the maintenance service, the agents, may use this "information asymmetry" with respect to the actual work done, to behave in an opportunistic way. They may

be tempted to provide suboptimal service (or even no service at all) without running a big risk of being held accountable. This is why it is important to look more closely at the types of Principle-Agent problems that may be prevalent in a given situation and devise contractual measures that can counteract such deficiencies.

The purpose of this Module is to describe different types of potential Principle-Agent problems, to discuss the consequences they have on maintenance service provision, and to introduce some ways to cope with such problems.

What are different types of Principle-Agent problems that may arise in maintenance service provision?

The major Principle-Agent problems to keep an eye on in the context of maintenance service provision are the following:

- The "Moral Hazard" problem
- The "Hold-Up" problem
- The problem of "Adverse Selection"

The "Moral Hazard" problem

A moral hazard risk arises whenever two actors are joined in a client-supplier relationship. The client (principal) commissions the supplier (agent) to perform a service on his behalf and thus confers a certain scope for decision-making on the supplier. If we presume that the agent's activities cannot be directly monitored by the client, and that the agent makes certain observations during the execution of the order which the principal has not made, then this leads to an asymmetrical information status between the two actors concerned. If it is also presumed that the task is so complex that it can be influenced by many external factors, the following problem can arise. Following the signing of the contract, the agent might reduce his efforts to fulfil the terms of reference (reduce his cost), without the principal being able to call him to account. The agent can always claim that a poor result is due to circumstances beyond his control, thus relieving him of any guilt or responsibility.

Box M7-1: Facing Moral Hazard problems in maintenance provision – an example

A water user association or an irrigation district has established a professional maintenance unit. The staff of that unit may be asked by the board of the association to prepare a asset management plan (see Module 2 in this Guide). In doing so, the staff might, on the basis of its professional judgement, make the interim decision to replace certain infrastructure parts with new equipment. Additionally, they may also decide to plan a level of maintenance well above the "real" requirements. In doing so they behave – conciously or unconsiously – in an opportunistic way, trying to secure their own positions and maximize the funding for their unit. In presenting its maintenance budget requirements to the board, the professionals take advantage of the information asymmetry faced by the board. Given all the technical details and judgements involved in developing the overall plan, information that cannot be available to the decision makers, board members may be unable to understand or change underlying decision criteria. The situation is analogous to that of a patient of a highly specialised doctor who can hardly judge the therapy if he does not even understand the diagnosis.

The board faces a Moral Hazard problem: Shall it trust the professional competence of its maintenance unit or will it be better to assume (at least some) opportunistic behavior of this unit and therefore reduce the fund request when deciding upon the budget to be allocated?

The "Hold-Up" problem

Hold-up problems arise in service relationships in which the potential service recipient has engaged in significant prior investment in the service to be expected. In such situations, the potential recipient is heavily dependent upon service delivery and on the service provider. In case the client (the principal) does not receive the expected service, all his investment might be in vain. The danger exists that such a unilateral dependency may be exploited by the service provider in order to extract particular favours ("sidepayments") from the client. The client may also take advantage of the dependency by negotiating a premium fee for service or by cutting costs and providing sub-optimal service. This danger is particularly high if strong information asymmetries exist between supplier and

recipient and if external conditions beyond the influence of the provider may cause high uncertainty about the level of service that will be provided. The provider can then blame these conditions as an excuse in case of non-delivery or sub-optimal provision of a service.

Box M7-2: Facing a Hold-Up problem in maintenance provision – an example

A typical Hold-Up problem in irrigation arises where the supply of equipment is implicitly (but not formally) coupled with the subsequent provision of maintenance for this equipment. The supplier of a particular set of pumping gear, for example will, in most cases, be asked to perform maintenance services at least for specific maintenance tasks that require specialist know-how that only the supplying company possesses. In cases like these, the principal, the irrigation agency or the water user association, might have to face a Hold-Up problem. Since the principal has made a specific investment, buying a special pumping set that is only available from a particular firm, this firm may use the situation to its advantage and charge excess prices for maintenance service.

The problem of "Adverse Selection"

An Adverse Selection Risk exists whenever two actors are planning to join in a client-supplier relationship. The client (principal) intends to buy a service or a good from the supplier (agent). There might, however, be characteristics of the service or good which are unobservable to the client but known to the supplier. The supplier might not have an interest in revealing any information about these characteristics. As a result, the buyer might find himself trapped in an unfavourable exchange relation after signing a contract, or he might not enter the relationship at all because he anticipates being taken advantage of. Both of these outcomes can result in missed benefits for all partners. Better selection mechanisms (signalling and screening) offer solutions to these problems.

Box M7-3: Facing problems of "Adverse Selection" – an example

As stated above, adverse selection occurs when, before a contract has been signed. The buyer faces several options but runs the risk to make a suboptimum selection due to problems of intransparent information. One example from irrigation maintenance relates to the reluctance of international donors to fund long-term maintenance costs. Maybe one of the reasons is that they are aware of the difficulties involved in monitoring maintenance efforts. Thus, the donors refuse to commit themselves to maintenance funding in most cases, often incurring substantially higher rehabilitation costs instead.

How can we detect Principle-Agent problems in irrigation maintenance?

There are three aspects that are of importance here:

- *The first one* is that problems of "Moral Hazard" and of "Hold-Up" are most relevant in relation to maintenance problems.
- *The second one* is that we cannot strictly separate water delivery and maintenance when we try to address these problems. This is because Principle-Agent problems in water delivery may well be the root cause for deficiencies in maintenance.
- *The third aspect* is that we need to realize that *transparency* and *accountability* are key terms in this context.

Considering these three aspects, we may use the following steps in order to detect Principle-Agent problems in maintenance service provision.

What are solution approaches for Principle-Agent problems in maintenance service provision?

Attempts to improve service relationships by solving Principle-Agent problems generally take one of two directions. They either try to minimize the existing information asymmetry or they strive to bring about a coincidence of interests between the principal and agent through changes in the incentive systems. In most cases attempts to minimise information asymmetries will entail high monitoring costs. In many situations such attempts may upset existing divisions of labour

Detecting Principle-Agent problems in irrigation maintenance

1. Analyse the service delivery system for water and identify deficiencies in primary or supporting services (Follow Module 4 in this MAINTAIN Guide).
2. Taking these cases of deficient provision of services or supporting services, find out what are the contractual mechanisms that govern that relationship (Follow Module 6 in this Guide).
3. Discuss with the involved parties whether or not these mechanisms of contractual governance create *transparency* for the principle or whether substantial asymmetries of information exist.
4. Discuss with the involved parties whether or not there are unpredictable external influences that may effect the quality of the service provision, and to what extent this has impacts on the *accountability* of the provider (agent).
5. In cases where both a lack of transparency and a lack of accountability are found, a problem of "Moral Hazard" will be most likely and the situation might invite the service providers to behave in an opportunistic way. They may face the temptation to use the situation to their own advantage, e.g. for rent-seeking purposes (With respect to Rentseeking in the context of maintenance service provision see MAINTAIN Thematic Paper No. 9).
6. Organize workshops or round-table discussions to find solutions to such problems, using the orientations given below.
7. In case no such problems can be detected in the context of water delivery, proceed to maintenance service provision and follow the sequence of steps 1 to 6 as mentioned before.

and responsibilities and hence create greater inefficiencies. Changing incentive systems such that they bring about coincidence of interests may also result in substantial costs. The basic idea of creating incentives in service delivery systems is to reward providers in direct relation to their contribution to the service provision process. It is then in their personal interest to make improvements in service provision. This is why a full or partial financial autonomy for the provider seems to be of prime importance. The question then is to find institutional arrangements that

bring about motivation for the provider to "search for excellence" in service provision.

Orientations for possible solutions with respect to Principle-Agent-Problems are summarised in Table M7-1 and discussed more in detail in the following text.

Table M7-1 : Types of Principle-Agent problems and solutions in service relationships
(see MAINTAIN Thematic Paper No. 10 and MAINTAIN Case Study No. 3)

	Adverse Selection	**Moral Hazard**	**Hold up**
Type of Problem	Risk of a suboptimal selection of a service provider/agent by the client /principal	Risk of suboptimal service provision due to opportunistic behaviour of the provider / agent, who, however, cannot be held accountable	Particularly strong risk of "Moral Hazard" due to pre-service investments incurred by the client / principal and resulting crucial dependence of the client from the service provision
Origin of Problem	Information asymmetry	Information asymmetry	Information asymmetry coupled with one-sided dependency caused by specific pre-service investments
Causes behind Information Asymmetry	Qualification of service provider / agent and quality of service provision not known	Detailed activities of provider/ agent and external influences on these activities not known	Detailed activities of provider/ agent and external influences on these activities not known
Time when Problem is Acute	ex ante	ex post	ex post
Theoretical Approaches to Problem Solution	Create/improve selection mechanism	Create/improve incentive systems that counteract "Moral Hazard"	Vertical integration or creation of mutual dependencies
Examples	■ "Signaling" or exposing proof of qualifications or information on service delivery	■ Improve return/ compensation for service delivery ■ Team building ■ Manipulation of "Outside Options"	■ Create joint property of resources for agent and principal ■ "Exchange of hostages" or handing over security to principal

According to theory the major paths for solutions to Principal-Agent problems in service relationships are the following:

1. "Moral Hazard": (Again: This is the risk of suboptimal service provision due to opportunistic behaviour by the provider, who however cannot be held accountable by the client.)

Approaches to solutions may be the following:

- *"Performance Compensation"*
  In this case the client/principal tries to couple the level of returns/compensations for the service to verifiable indicators or other facts that can be influenced by the provider/agent. One way may be to agree upon individual performance levels, as in Management by Objectives.
- *"Tailoring" the scope of the service to be provided*
  In cases where a provider/agent is supposed to provide several services that make use of the same pool of resources, she may be tempted to find excuses for a sub-optimal level of service provision by pointing to problems with the provision of another service. She also may have an interest in diverting resources from the provision of one service to that of another. This can be counteracted by "tailoring" well-defined service orders and allocating corresponding budgets to them.
- *"Team-Building"*
  Information asymmetry may be avoided through team-building efforts where team members each have an interest in preventing "moral hazard" actions by others. Social pressure and control can thus bring about an efficient provision of service.
- *"Decentralisation of Ownership"*
  The idea here is, that in cases where a local actor is the owner of certain resources, she may treat these resources with more care than she would do otherwise. Hence, one may try to transfer certain critical resources to the ownership of this actor.

- *"Efficiency Pricing"*
  In cases where a client (principal) can get hold of services on the basis of agreements for returns (payments) that do not reflect the scarcity of the service, she will tend to overuse and waste the service. Hence "efficiency pricing" is needed to prevent such Moral Hazard problems.
- *Manipulation of "Outside Options".*
  In this case, the client/principal tries to stop undesirable "side-actions" by the provider/agent that may have an effect on the service in question.

In the case of the Moral Hazard example mentioned in Box M7-1, the following approaches (and combinations thereof) might be considered.

- *One or two of the board members may join the maintenance planning process. This corresponds to the "team building" approach, and also tends to reduce information asymetries.*
- *The board may opt for a better "tailoring" of the maintenance service (see above) and separate responsibilities, for example, for irrigation maintenance and for the maintenance of vehicles and equipment which were combined. This may restrict possibilities for the maintenance staff to divert resources from one service to the other and find excuses for sub optimal levels of both.*

2. The "Hold-Up" Problem: (Again: This is when there is a particularly high risk of "moral hazard" due to highly specific pre-service investments incurred by the client and resulting dependence by the client on the service provider.)

Approaches to solutions may be the following:

- *"Joint ownership of resources"*
  The dependence of the client/principal upon the agent may be avoided through the creation of joint ownership of resources. Thus, both partners will be mutually dependant on a functioning service provision.

- *"Exchange of hostages"*
  The provider/agent may hand over some kind of security to the client/principal to convince her of his good intentions and to transform the unilateral dependency into a mutual one.
- *Avoidance of high specificity of investment*
  In this case, the "principle" will try to specify her investment needs in such a way that there may be several potential offers at the market.

In the case of the irrigation maintenance example for a Hold-Up situation, mentioned above in Box M7-2, the following approaches (and combinations thereof) might be considered.The irrigation agency or water user association (the principal) might opt for more standard types of pumping gear in the future for which there are multiple offers on the market (Avoidance of high specificity of investment)

- *When buying the pumping equipment, the principal might insist on some kind of service contract that is coupled to the buying contract. In this case, a future Hold-Up situation might be avoided (Exchange of Hostages).*

3. "Adverse Selection": (Again:This is the risk of sub-optimal selection of a service provider by the client due to information asymmetries.)

Approaches to solutions may be the following:

- *"Signaling"Activities*
  To avoid "adverse selection" of a service provider (agent) by the client (principal), the provider may try to engage in "signaling" activities. She can try to provide proof of her ability to provide a service or may try to make the quality of her service provision transparent to the client
- *"Screening Mechanisms"*
  While the costs of "signaling" activities are borne by the agent, the principal may proceed to collect information on the qualifications or service provision

capacities of the agent. She may do this using so-called "Screening-Mechanisms". She may look for references from third persons, carry out tests, or engage in other information collection activities.

In the case of the irrigation maintenance example for an Adverse Selection situation described in Box M7-3, the following approaches (and combinations thereof) might be considered.

Donors might collect better data on existing maintenance practices in particular countries. They might then make future agreements to the provision of funds for new irrigation projects or for rehabilitation measures – including some initial funding for maintenance during a "start-up phase" – subject to favorable maintenance ratings. ("Screening mechanisms").

Recipient countries might engage in similar exercises and "signal" their (hopefully) positive maintenance strategies and records.

Module 8

Free Riding – A central governance problem related to maintenance

(Supporting Documents: MAINTAIN Case Studies No. 3 and 7, MAINTAIN Thematic Paper No. 9; GTZ-publication No. 263).

The purpose of this Module is to explain the causes for problems of free riding and to highlight its importance as a prime "motivation killer" or disincentive for the provision of maintenance services. The Module points to some options for the solution of free riding problems.

What is "free riding" and what are causes leading to it?

As mentioned in chapter 2.3 of Part One of this Guide, maintenance in many cases is a so-called "collective good," or more precisely, a "club good." This means that the maintenance service in most instances is not provided for an individual but for a group. Where it is not possible to exclude non-payers (or "free riders") from receiving the same maintenance services as payers, we say that there is a problem of "open access" or "non-excludability" of the service. By contrast, effective governance by an irrigators' group will institute arrangements that prevent free riding.

Free riding leads to a serious "feed back deficiency" between the service provider and the client. The provider cannot exclude non-paying demanders, and in turn the individual clients, the water users, loose their payment power to enforce high quality service provision. This normally entails a serious breakdown of incentives to further service provision: even those who are willing to pay for the service will discontinue to do so when they become aware that free-riding is increasing. With increasing free-riding the financial

Box M8-1: Free-riding behaviour in maintenance provision – a rationality trap

Where maintenance is provided by a community of water users as a club good, the individual water user is faced with a conflict between his own interests and those of the community. This conflict – social scientists speak of a "prisoner's dilemma" – can damage the community interests, and thus ultimately also the water user's own interests.

The fact that a water user who fails to make his contribution cannot be excluded from the benefits of maintenance tempts individuals to think along the following lines:

The economically most beneficial situation for the individual arises when all other individuals contribute towards maintenance, but the individual concerned plays the "free-rider" by profiting from the maintenance without making any contribution. The profit he derives from irrigation is thus – unlike for the other users – not diminished by the costs of maintenance inputs from his side. The individual sees the damage which he inflicts on the community by withholding his contribution as minimal, in view of the large number of contributors.

The economically most disadvantageous situation for the water user in question arises when he pays his contributions in full, whilst everyone else tries to act as a free-rider. The individual's profit is then reduced on the one hand by the fact that no maintenance or only sub-optimal maintenance can be carried out on the system. Secondly, the water user's profit is reduced by the fact that he, unlike everyone else, has contributed towards maintenance.

The economic conditions which emerge when all users, including the individual considered here, make their contributions, are calculated by the individual as falling between the two aforementioned extremes. The added profit is confined to the additional benefit resulting from the now fully-maintained system, minus the contributions paid by the individual. The water user will accept this "second-best" solution unconditionally if and when he can be certain that everyone else will act in the same way. However, once this becomes uncertain, the picture changes:

In a situation like this where it cannot be ruled out that free-riders will go "unpunished" for profiting from community efforts (which is often the case with larger systems and where there is a lack of legal security or where means of imposing sanctions are inadequate) there will therefore be a tendency for individual users to withhold their contributions "just to be on the safe side". Users will do this especially once the contributions become disproportionately high in relation to the overall benefit. This, however, will undermine the morale of those actually making their contributions.

The number of contributions made will fall, until the burden of payment on the remaining cooperating users becomes so great that they too stop paying. The damage inflicted on all by non-maintenance of the system now falls back on the individual. His calculating attitude turns out to be a **rationality trap**, in that the second-worst situation arises: Whilst the individual has saved his own contribution, the (additional) benefit from maintenance has not materialised. Instead, significant damage has been suffered by all. The rationality which had been based on the individual's own interest has turned out to be a trap.

The reader ought to be familiar with such prisoner's dilemma-type situations from his or her own experience, even though he or she may not have any experience of being a water user. The car driver who knows thats he should stop driving in order to avoid major detriment to the community in the form of air pollution is in a comparable situation. Calculating her own cost-benefit ratio, the driver will assume that the benefit which would be derived by the community if a single car – i.e. her car – were to be driven less, would be minimal. In other words, it would only make sense to stop driving if he could be certain that most other drivers would act likewise. However, since the level of uncertainty in this case is high, she will attempt to avoid the situation most disadvantageous to herself – namely that everyone else carries on driving, but not her, and the environment continues to be damaged. Since most other drivers will also do the same thing, damage to the environment continues – up to a point at which the community and therefore the individual suffer severe damage.

This example, which is not related to irrigation, is meant to demonstrate that prisoner's dilemma situations can occur as problems in the control of collective goods in a wide variety of social systems in which large numbers of individuals are engaged in community activities.[5]

basis for the provision of the service will erode and provision will eventually stop.

How can free riding problems be overcome?

Strategies that intend to overcome free riding problems related to maintenance will vary with the kind of institutional arrangements that govern the relationship between the provider and the client in the service relationship (see Module 6 of this Guide):

5 A basic discourse on this theme was first produced by Mancur OLSON, bearing the revealing title of "The logic of collective action" Cf. OLSON, 1968.

Scenario 1: Maintenance as a pure market service

This is a situation where maintenance is provided on a contract basis "on the market" to a private farmer or to the government. The maintenance service in these cases is a so-called "private good". Potential problems relating to collective goods, and the associated rationality traps, do not arise in the service relationship.

Scenario 2: Maintenance as a provision by and for a collective entity

Where maintenance is provided by and/or to a group of farmers, free riding may occur. It is appropriate to distinguish between two basic types of collective systems. These are the relatively small *primary group* and the *larger self-administered systems* (which are too large to enable all actors to interact directly on a face-to-face basis) (see Module 6). Solutions to free riding are likely to differ in the two contexts.

With *primary groups* the strategy to overcome tendencies towards opportunistic behaviour arises more or less of its own accord. All members of the group know each other and have close social relationships with each other. As a result, the *social pressure* on the individual member is so great that free-riding almost never occurs, or if it does then it leads to serious social sanctions. From the point of view of the individual member, rationality traps are virtually non-existent in primary groups.

By contrast, in *larger self-administered systems* the problem of rationality traps does arise. In this case, social sanctions are very difficult to apply. It is no longer the case that each member is kept informed as to the activities of each of the other members. Shielded by the anonymity of the large group, it is usually possible to indulge in opportunistic behaviour without any difficulty.

The following strategies may help to counteract free riding behaviour in this context.

The "small group strategy"

The *"small group strategy"* involves keeping the group which administers itself as small as possible, restricting it to the size of a primary group. To put it another way, application of the small group strategy amounts to the formation of smaller sub-groups which are just about capable of functioning on the basis of mutual social responsibility. Important factors here are the homogeneity and cohesiveness of the group. The weaker they are, the smaller the group size needs to be.

"Moral persuasion"

A further strategy in collective systems involves "*moral persuasion"*. The aim here is to ensure that free-riding is stigmatised within the community as anti-social, becoming the subject of moral disapproval. However, there are strong constraints on moral persuasion, especially in larger groups, and where the share of opportunity costs for positive social behaviour is high.

"Selective incentives"

Another strategy under the given institutional conditions here involves "*selective incentives"*. Selective incentives are goods or personal advantages designed to induce potential free-riders to make their contributions to the collective good, e.g. to maintenance. To achieve this they are offered additional benefits, the receipt of which is dependent on their contribution to the maintenance effort. Anyone who free-rides under these conditions can be excluded from obtaining the additional benefit. One problem with selective incentives consists of the fact that the benefit in question needs to be financed from the contributions to the collective goods. Consequently, they are tied to a certain level of contributions. In addition, the benefit must be offered on better terms (such as more cheaply) than on the market. Neither of these conditions with respect to selective incentives is easy to meet in water

user organizations (e.g., application of special material allocations or special services).

"Coercion"

A final strategy pursued for mitigating rationality traps in collective systems is that of *coercion*. It is important here that this coercion is not applied against the actors' will, but rather with their consent, in order to provide everyone with the security that nobody will indulge in free-riding. The problem with this strategy is that in many cases this premise is in reality not fulfilled, or that some individuals impose their will on others.

The coercion strategy may consist of cutting irrigation water supplies in cases where maintenance contributions have not been paid. In the "Valle Alto" irrigation scheme in Bolivia such a strategy is agreed upon by all participating communities who have to pay the whole share of their members' fees in advance of the irrigation period, unless the supply to their community fields will be cut.

Scenario 3: Maintenance within the scope of a public utility

An irrigation organization which functions as a public utility, and whose survival is dependent on as complete a collection of service charges as possible, will have to link its maintenance provision to the service of water supply. Ideally it needs to create the technical and organizational preconditions for water to be allocated, measured and charged to *individuals* or *small groups*. To provide water to *larger groups* that cannot solve their free riding problems will jeopardize the provider's survival.

Scenario 4: Maintenance in state-administered irrigation systems (central administration)

As a rule, this will involve large systems. Applying the "*small groups"* strategy here would mean forming

smaller sub-groups from the outset to function on a primary group basis. For existing systems this will not always be easy to achieve.

One important strategy here will be *selective incentives*, which the state organization can make available to the water users who pay the water charges.

In reality, the predominant strategy with state organizations will be *coercion*. By means of directives and corresponding monitoring, water users will be required to practice "production under close supervision". Most large colonial and post-colonial irrigation systems have relied on this strategy. However, the information and monitoring activities needed to identify and sanction free-riders as a rule involve high costs. These costs are added on to the already high costs of state responsibility for operation and maintenance of the systems. It therefore comes as no surprise that many governments consider it appropriate to transfer some public systems to the water users. In this context it is often overlooked that the size of the systems often makes the strategies to deal with the problems associated with collective goods fairly difficult, even with self-administered systems.

Module 9

Institutional Arrangements for Irrigation Financing

(Supporting Documents: MAINTAIN Thematic Papers No. 5 and 12; MAINTAIN Case Study No. 7)

What is the importance of institutional arrangements for irrigation financing?

In every exchange relationship, where a good or a service is delivered by a service provider there needs to be a "return" or a "payment" to compensate for the provision. There are practically no such relationships that can function without an appropriate or agreed return. Relationships in charity may be an exception, when altruism induces a person or an organization to provide some goods or services and not ask for compensation. Even in this case there is a whole strand of literature that discusses arguments that there are "invisible" returns like a good conscience, avoidance of social sanctions, gain or maintenance of political influence, etc.

In the following we use the term *"payment"* for all kinds of returns, even if these returns have a non-monetary form.

The payment in an exchange relationship basically has four functions:

- The payment is supposed to cover the costs of the provision;
- Beyond cost-recovery, the kind and level of payment constitute the material incentive (or disincentive) for the provider to engage in the exchange. They enable subsequent exchanges between the partners to continue and hence are the bases for a sustainable exchange relationship;
- The payment creates accountability. The provider will feel accountable to those who pay for the provision. A closed loop between provision and payment is therefore a key aspect of functioning service provision.

- The payment helps to create "customer sovereignty". To have the capacity and the authority to pay – and to delay, withhold, reduce or increase payments – is an essential factor that gives both incentives and power to the customer.

Institutional arrangements for financing would hardly be a topic worth discussion if all exchange relationships would have the form of the bilateral closed exchange that is prevalent in a simple commercial relationship. The service provider provides the good or service and the customer simultaneously assumes the roles of "arranger," payer and consumer of the service (see Fig. M9-1 on page 170). The arranging function here includes the function to select the provider, to decide upon the terms of the provision, to conclude an agreement or contract with the provider and to monitor the provision.

Unfortunately, many exchange relationships, especially in public service provision, do *not* correspond to such a simple arrangement. The functions of arranging, paying and consuming are often assumed by several actors. For example, the customer may be a needy individual requiring welfare support and is only the consumer of the welfare service. Other entities perform the functions of payer and arranger of the service (see Fig. M9-2 to M9-5 on pages 170 and 171). Service provision now takes place in the context of a "multi-actor" arrangement. The question arises, What are the rights, rules, regulations, agreements and procedures (i.e.,the institutional arrangements) that govern such a service network of actors? Although we have touched upon this issue several times before, the importance of these institutional arrangements cannot be overstated. Without well designed arrangements of this kind, service provision will not take place in an effective and efficient way. This is a lesson which has been learned by hard experience in irrigation service provision in the past.

What is the purpose of this Module?

The classical response to problems of maintenance in irrigation, a response especially given by development banks, has been to raise water fees. With increased returns from irrigation service provision (so goes the argument) the major problem related to maintenance (i.e., the lack of funds) can be overcome.

Implicitly, such a line of argument relates to a model of service provision as it is shown in Figure M9-1 on page 170. There is a closed feedback loop between service provision and payment and hence shortages of funds will be eliminated by increased payments.

This Module – and much of the discussion of this Guide – centers around the argument, that in most cases institutional arrangements for irrigation service provision are complex. It is not only the insufficient level of funds but also the deficiencies in institutional arrangements that are the root causes for maintenance problems. In many cases actual levels of water fees paid are strongly influenced by the institutional arrangement that is in place.

The purpose of this Module is therefore to present a simple way for how to proceed when trying to assess the viability of institutional arrangements for the financing of irrigation services, and hence for maintenance. This Module is applicable in all institutional contexts defined in chapter 4. However, it will be particularly useful in context of type B, indicated in Figures 5 and 6.

The key questions to be asked

We propose that the following key-questions be asked when trying to assess the viability and effectiveness of incentives for a given institutional arrangement for financing irrigation services:

- Is there a closed feedback loop between services provided and payments made? In other words, is there a direct link between services and payments?
- Is full "customer sovereignty" assured? If not, what restrictions are placed on the functions of arranging and paying for services?

- Are subsidies provided? If yes, are they justified on the basis of well-specified conditions related to service quality?

What are the basic institutional arrangements for irrigation financing and how can we assess their potential "incentive effectiveness?"

In the following, we present and discuss five basic institutional arrangements for irrigation service provision and financing which we consider to be the most frequently encountered situations. Doing so, we refer to figures M9-1 to M9-5. Our brief discussion of these cases centers around the above-mentioned key questions, from which we draw conclusions about the results of incentives for both the service provider and customer. These cases are meant to guide practical attempts of professionals to assess institutional arrangements for irrigation financing. (Our rating of incentive effectiveness goes from "+++" for "very high," through "++" and "+" ratings for "high" and "low" respectively, to "-" as the rating for "non-existent").[6]

Institutional Arrangement 1: Private Service Provision (see Fig. M9-1)

As mentioned before, this is the ideal case of an exchange relationship: the loop between service provision and payment is closed, the customer has full "sovereignty" (i.e., assumes the arranging, payment and consumer functions) and no subsidies from a third party are involved.

Such cases do not only correspond to commercial service provision where the bilateral relationship is governed by market mechanisms. They also reflect the case of self-governed community irrigation systems where the community organization provides irrigation services to individual farmers who pay for such services (in monetary or non-monetary terms). Also, by way of their community membership and the mechanisms of participatory decision making, farmers influence the kind of services to be provided and thus retain the arranging function. (The larger the group and the less

6 For a more in-depht discussion on the preconditions for the effectiveness of incentives see Module 10 "Actor Specific Incentive Profiles".

direct influence the users have in arranging the service, the less sovereignty they will preserve).

Incentive effectiveness:
For the provider side : +++
For the user side: +++

Incentive effectiveness can be ideal. In cases where the payment is appropriate and where Principle-Agent-Problems can be excluded (see MAINTAIN-Module No. 7), the provider faces optimal incentives to provide good services. The provider is also fully accountable to the users who retain full customer sovereignty. In cases of good service provision, the users will also have high incentives to maintain the service relationship.

Institutional Arrangement 2: Government Subsidy for Private Service Provision (see Figure M9-2)

Cases of government subsidy for irrigation service provision abound in developing countries. The case referred to here and illustrated in Figure M9-2, however is special insofar as subsidies go directly to the users who thus retain their customer sovereignty in the relation with service providers. This may be a case

Box M9-1: Government subsidy to private service provision – the case of Southern France

Cases like these are found for example in the Gascogne-Region in Southern France (see MAINTAIN Case Study No.2). Water user associations in this region – the so-called "associations syndicales authorisées" (ASA) – are entitled to various subsidies for irrigated agriculture from the state. They receive large subsidies for the construction of irrigation systems and during the operation phase they benefit – amongst others – from subsidies for water saving system components. However, after the construction and after an initial one-year operation phase run by the state owned "Compagnie d'Aménagement des Coteaux de Gascogne" (CACG), the ASA are free to choose whatever service providers for operation and maintenance provision they prefer. The ASA enter into market based contracts with these providers and thus assume full customer sovereignty in the service provision process.

where water users receive funds from the government that are completely free to enter into service arrangements with particular service providers to whom they pay competitive prices.

In such cases, incentive effectiveness might be rated as follows:

For the provider side : +++
For the user side: +++

There is a direct and closed loop between service provision and payment. The payment, arranging and consumer functions are all assumed by the water users and the subsidies are linked to clearly pre-determined conditions that are linked to service quality (e.g., procurement of water saving equipment).

Institutional Arrangement 3: Government subsidy and arranging function jointly assumed between government and users (see Fig. M9-3).

Also in this case, the government provides a subsidy to maintenance. However this subsidy is tied to certain preconditions. Moreover, work quality may be subject to government monitoring.

Such an institutional arrangement maintains a *closed loop of service provision and payment* between the service providers – e.g. local artisans – and the users as customers. However, *customer sovereignty* here is restricted. Being the paymaster gives the WUA some control over maintenance service quality, however the arranging function is exercised jointly with the government since the responsible government entity monitors work quality in making payments to the WUA under their contract. And finally, in the case discussed above, *government subsidies* are not clearly earmarked. As mentioned before, one part is provided to each newly formed WUA, the other part is allocated on a per-acre basis. The subsidies have no link to service quality.

Conditions like these may justify an incentive effectiveness rating as follows:

Box M9-2: Government subsidy and jointly assumed arranging function

Examples for such cases are reported for the post-reform maintenance service provision in irrigation schemes in Adhra Pradesh, India (see MAINTAIN Case Study No. 5). At the level of minor canals and below, water user associations (WUA's) receive maintenance grants from the government to organize and carry out the work. There are two types of grants. The first is a block grant to each newly formed WUA for emergency repairs and maintenance, to be used as the WUA sees fit. The second grant is made subsequently in a fixed amount per acre of registered irrigated land within the WUA area.

The procedure for spending these funds is the following. WUA's and their committees identify maintenance priorities and then ask special government units to prepare plans and quantity estimates for the work to be done. Once agreed upon by both sides, the government concludes a contract with the WUA to carry out the work. Then, the WUA can directly employ farmers or local artisans for this purpose or it can subcontract to a third party. The government then makes payments to the WUA on a predetermined schedule related to work accomplishment.

For the provider side: ++
For the user side: +

The *providers* of the maintenance are directly paid by the WUA and nominally they are fully accountable to them. Hence, they may have high incentives for good performance. In reality however, they may be aware that the WUA do not have the full engineering competence to judge work quality in detail. Given the partial role of the responsible government entity to monitor and approve work quality, there may be cases where contractors can use this splitting of roles to their advantage.

The *users* have the incentive to take initiatives with respect to maintenance, even if their sovereignty is restricted by the government. However, the fact that subsidies are given without a clear earmarking to service quality might induce users to go for "gold plated maintenance," since they perceive opportunity costs of

funds for maintenance to be very low (see Module No. 3 of this Guide). This means that incentives are not fully effective.

Institutional Arrangement 4: Service provision in charge of a financially autonomous government agency (see Fig. M9-4).

In such cases, a government agency or parastatal organization is the arranger and payer of maintenance services. Water users are consumers of these services insofar as they can take advantage of the level of water delivery service which they have requested. The government agency or parastatal organization can either perform the maintenance service on its own – "en régie" – or subcontract it to a commercial provider. Water fees paid by the users provide sufficient cost recovery.

Box M9-3: Service provision by financially autonomous government agency

Arrangements like these are found in the above-mentioned region in Southern France where the "Compagnie d'Aménagement des Coteaux de Gascogne" (CACG) holds the mandate to manage water resources (see MAINTAIN Case Study No. 2). The institutional arrangement discussed here corresponds to the situation faced by CACG in the so-called "périmètres en concession". Here, the CACG is commissioned by the state to operate and maintain the irrigation facilities in various perimeters totalling some 70,000 ha. These services are paid for by the contractually agreed upon fees the irrigation farmers pay the CACG.

In general, such arrangements with respect to incentive effectiveness can be rated as follows:

For the provider side : +
For the user side: +

The agency holds both the arranging and the payment function vis-à-vis the provider. In cases where no subcontracting is foreseen these functions coincide

with the provider function (service provision 'en régie'). In both cases, there is *no customer sovereignty* of the users toward the service provider. Consequently, the providing units will feel accountable to the agency and not to the users, an arrangement which may give rise to services that do not really correspond to actual needs. Incentives on the *provider side* hence are more or less deficient, depending on the management capacity of the agency.

Incentive effectiveness on the user side is restricted by the missing customer sovereignty. However, the *loop of services and payments* is closed due to the financial autonomy of the agency. The user fees directly feed into the service provision process and thus provide a secondary link between payment and performance. Incentives on the user side to request and monitor maintenance services (and withhold payments in case of unsatisfactory provision of services) may be low, but are still not without effect.

Institutional Arrangement 5: Government Administration

This is the well-known case of medium and large-scale government administered schemes, as they exist in many parts of the world, especially in South Asia.

The *feedback loop* between service provision and payments is interrupted. Maintenance budgets are allocated by Ministries of Finance without any obvious link to service performance. There is no *customer sovereignty* at all, since maintenance is either provided or subcontracted under the responsibility of particular government departments. Water fees normally are highly *subsidized*, however without any link of the subsidy to variables that influence service qualiy.

In this case, the answers to all our three key questions point to low or non-existing incentive effectiveness, the likely ratings in such cases will be:

For the provider side: -
For the user side: -

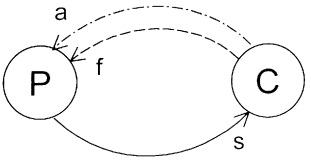


Figure M9-1: Private Service Provision

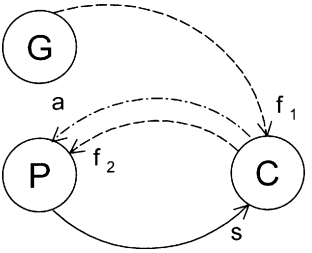


Figure M9-2: Government Subsidy to Private Service Provision

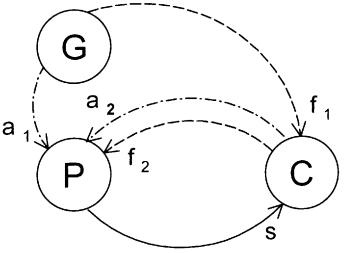


Figure M9-3: Government Subsidy and Split Arranging Function

Legend

——→	s	service provision
- - - - →	f	payment / finance
—·—·→	a	arranging function
	P	provider
	C	customer / user
	G	government entity

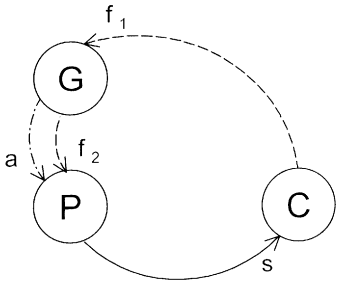


Figure M9-4: Financially Autonomous Government Agency

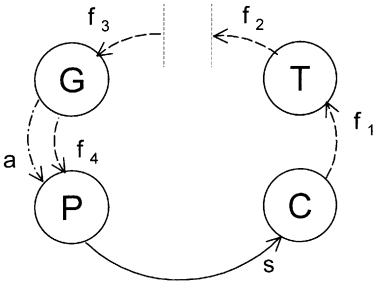


Figure M9-5: Government Administration

Legend

——→	s	service provision
- - - - - →	f	payment / finance
-·-·-·→	a	arranging function
	P	provider
	C	customer / user
	G	government / agency
	T	treasury

Module 10

Actor Specific "Incentive Profiles"

Why is the analysis of incentive deficiencies essential in the context of maintenance service provision?

Irrigation in most countries of the world faces a problem which we have described in chapter 1 of Part One of this Guide as a "maintenance paradox". While poor maintenance has been found to be one of the major causes for suboptimal performance of irrigation systems world wide, irrigation research and project appraisals in most cases hardly pay any attention to maintenance.

As we have stressed in the introductory chapters to this MAINTAIN Guide, we adopt the premise here that the general lack of commitment toward solving the problem of inadequate maintenance of irrigation systems is primarily due to weak institutions that do not create appropriate incentives to motivate stakeholders to ensure adequate maintenance.

To illustrate this point, we repeat in Table M 10-1 the examples of incentive deficiencies that are prevalent in a conventional top-down administrative setting of irrigation maintenance.

The purpose of this Module is to provide guidance for the identification and elimination of incentive deficiencies in maintenance service provision for irrigation. In so doing, the Module refers to previous Modules as well.

What are "incentives" and when are people motivated to act in a certain way?

When talking about incentives, we need to be aware of the difference between *incentives* and *motivation*. An incentive is any reward or sanction, intended or inadvertent, which has as its effect a modification of behavior. In contrast, motivation is the condition of being encouraged to behave in a certain manner.

In other words, incentives, as rewards or sanctions, are causes that bring about the effect of motivation. They do this *if and only if* appropriate conditions or

Table M 10-1: Examples of incentive deficiencies for irrigation maintenance

Stakeholder	Incentive Deficiencies
Senior Irrigation Officials	■ Low political benefits, high opportunity costs ■ Low, delayed visibility of benefits of maintenance ■ Low budget priority ■ Rehabilitation projects create political support
Irrigation Agency Management	■ Budget allocations unrelated to fee collection rates ■ Total control over O&M funds requires less accountability to users than cost-sharing arrangements ■ Accountability to internal hierarchy, not water users
Operational Staff of Irrigation Agencies	■ Maintenance lacks professional appeal ■ Deterioration rewarded by rehabilitation projects ■ Accountability to internal hierarchy, not water users
Water Users	■ Irrigation infrastructure seen as government property and responsibility of government to maintain ■ No relation between payment of water fees and quantity or quality of maintenance ■ No clear water rights ■ Not involved in priority setting for maintenance works
Foreign Donors	■ Difficulty monitoring use of resources for maintenance ■ Difficulty monitoring benefits of effective maintenance ■ Pressures to perpetuate financing of capital intensive projects, such as rehabilitation, modernization and expansion

"conditioning factors" are given. An increase in salary may be forseen by the management of an irrigation agency to motivate its staff to tend more intensively to maintenance issues. However, if the condition for salary increase is the number of years in service (the "conditioning factor"), and if the value system of the staff is dominated by monetary benefits, it is highly

unlikely that any improvement in maintenance provision will come about with such an incentive. Unless maintenance activities and results are linked by an appropriate conditioning factor to the value system of the agency staff (e.g. using a premium system that is tied to the results of external audits) motivation effects will remain negligible.

Most theories of motivation (e.g. the much-cited theories of Maslow, Herzberg and others) assume that people have needs for money, belonging, friendship, recognition and so on, to which they react. Hence, if a "manager" can identify these needs and manipulate the means for their achievement, then his purposes can be served as people respond to their internal drives.

Entering the world of *service provision*, as it has been referred to in this Guide, we have to realize that

- In service provision there are several – at least two – actors ("exchange partners") that are independent in the sense that they are not necessarily engaged in a "manager-subordinate" relationship with each other. Hence, the assumption, that there is a "manager" who "elaborates" an incentive system for the other actors is an oversimplification in many cases.
- In service provision and especially in complex service delivery systems, people interact with other people. This means that the assumption that people are basically passive responders to external incentives is also an oversimplification. Instead, people devise strategies to fulfill their needs and wants in a proactive way.
- Thinking in terms of service delivery emphasizes the necessity for considering relationships between people in order to understand their behavior. In systems of multiple actors, such relationships are subject to different goals and expectations of the actors in the exchange. Hence, they create both opportunities and threats for the involved actors. These are factors that influence motivation.

Taking such a perspective and extending traditional thinking on motivation into the realm of service thinking and exchange relationships, we take the following conceptual approach: To see people act in a certain way, it is not sufficient to have an attractive incentive system with functioning "conditioning factors". Instead, people need to have:

- A. The *possibility to act* in a certain way, meaning:
  - (A1) Framework conditions must be such that people are not constrained to act in the intended way,
  - (A2) People must have a chance to participate in the process of determining the "intended way" of acting ("goal setting"),
  - (A3) Necessary interactions with other people need to come about in such a way that agreements about content and conditions of the exchange relationship are established and adhered to,
  - (A4) People must receive appropriate compensations for their actions/services and thus receive the necessary resources or financial ability to go on acting as desired or agreed.
- B. The *ability to act* in the desired way, meaning:
  - (B1) People must have the qualification or functional ability to act in the desired or agreed way,
  - (B2) People must have the social/political authority to act in the desired way,
  - (B3) People must have the appropriate rights to act in a certain way (e.g. use rights, control rights).
- C. The *motivation to act* in the intended way, meaning:
  - (C1) People must perceive the benefits of the action that accrue to themselves (including material and immaterial incentives) to exceed the costs (including transaction costs) of their own contribution,
  - (C2) People must have confidence in the terms and conditions of the agreements, rules, contracts or

procedures that govern their interactions with other stakeholders,
- (C3) People must see the goal of the action in line with their own interests and value system.

In this Guide, we perceive "incentives" and the "incentive systems" not only in terms of rewards and sanctions but also in terms of the above-mentioned conditions that create both the *motivation* to act and the *possibility* and *ability* to act. We assert that the lack of possibilities and/or abilities to act can be perceived as serious disincentives by the potential actors.

How does this Guide contribute to Incentive Deficiency Analysis and to the solution of incentive problems in maintenance provision?

This Guide and the entire set of Modules are a contribution to the analysis and improvement of incentive deficiencies in irrigation maintenance. With reference to the above- mentioned factors of a comprehensive incentive system, the Guide provides the following concepts.

- A. The *possibility to act* in a positive way with respect to maintenance provision:
  - (A1) requires the analysis of "framework conditions"[7] and the tailoring of maintenance strategies to the respective conditions. *With the presentation of the instrument of "Strategic Institutional Positioning" (SIP) the Guide responds to this requirement (see chapter 4.1). SIP provides direction for devising situation-specific maintenance strategies that fit with the existing institutional framework conditions.*
  - (A2) demands that the major stakeholders participate in determination of objectives. *In Module 1, this Guide presents approaches to determining objectives that explicitely consider the role of the stakeholders in the process of setting objectives. Moreover, it shows how such approaches need to differ with varying framework conditions.*

7 Essential elements of the framework conditions in a service relationship are the "external institutional environment" (see chapter 3.1) and the "service agreement" (see chapter 3.2)

- (A3) asks for appropriate compensations for maintenance provision to be channeled to the service providers. *While this Guide does not touch upon the questions of water pricing and tariff setting, it deals with the necessary institutional arrangements for irrigation financing (Module 9). Doing so, it discusses a topic which is one of the major causes for deficient maintenance financing.*

■ B. The *ability to act* in a positive way with respect to maintenance provision requires that:

- (B1) people must have the qualification or functional ability to act in the desired way. *We hope that this Guide can help to improve qualifications of irrigation managers, planners and stakeholder representatives to deal in appropriate ways with topics that are essential for effective maintenance provision.*
- (B2 and B3) people must have the necessary *authority* and appropriate *rights* to act in a positive way with respect to maintenance. *In Module 5, the Guide presents an analysis of property rights and authority systems and thus contributes to overcome respective deficiencies.*

■ C. The *motivation to act* in a positive way with respect to maintenance provision demands that:

- (C1) people perceive the benefits of the action that accrue to themselves (including material and immaterial incentives) to the costs (including the transaction costs) of their own contribution. *In Module 3, the Guide presents a method for a "Rapid Assessment of Economic Incentives" for maintenance provision. With such a tool it will be possible to make a "quick and dirty" judgement as to the cost-benefit situation as it is perceived by the involved stakeholders.*
- (C2) people must have confidence in the terms and conditions of the agreements, rules, contracts or procedures that govern their interactions with other stakeholders. *In Module 6, the Guide*

introduces ways and means for how to analyse and improve the governance of maintenance provision. The tools presented in that Module are illustrated in numerous case examples of the MAINTAIN Case Studies.

- (C3) people must see the goal of the action to be in line with their own interests and value system ("goal congruence").

In the following, we present the instrument of "Actor-Specific Incentive Profiles" that directly relates to this latter requirement.

What is an "Actor-Specific Incentive Profile" (ASIP)?

As mentioned above, we perceive the actors involved in maintenance provision not just as passive reactors but as active initiators who pursue personal interests[8] and devise strategies to pursue these interests.

Therefore, we need to take these interests and strategies into account and find out whether or not and in what way these interests and strategies and the motivation to pursue them are effected by incentives and disincentives.

An ASIP is a format that tries to give a summary overview of different incentives and disincentives faced by an individual actor in connection with a particular service provision, in our case in connection with water delivery and/or maintenance in irrigation. Moreover, the ASIP identifies how these incentives and disincentives are linked to the actual or assumed interests and strategies of this actor. Trying to assess the effect of the different (dis)incentives on the motivation of the actor in question, ASIP provides a base for discussions on overall "incentive effectiveness" of a given service system relative to the specific actor. This overview provides a listing or profile of assessments of incentive

8 When we speck of the personal goals of individual actors – organiations, groups, persons – we use the term "interests" in order to make a clear distinction to the official goals set by organizations and groups.

effectiveness of a given service system arrangement for a selected actor in that system.

Methods for implementing an "Actor Specific Incentive Profile" (ASIP)

The methods for implementing an ASIP may vary depending on the circumstances. There may be "quick and dirty" rapid assessments, where rough assumptions about a particular actor's main interests and strategies are made, without this actor or representatives of this actor being present. There may be other situations, where in-depth workshop discussions seem worthwhile, with representatives of the actor in question playing a central role.

A particular difficulty is the identification of the interests and strategies of an organization or a group. The interest or *personal* goals of such an organization or group might differ substantially from its official goal. The official goal of a department may be to ensure optimal maintenance of irrigation infrastructure. However one may assume that the *interest* of the department may instead be to look after its own growth and survival and secure a rising share of next year's budget allocation. At the same time such a suggestion may be a gross misjudgement of a loyal and engaged department head who does his or her best to do a good maintenance job in the most cost effective way.

This is why it is important to realize that ASIP does not aim to work with real but with *assumed interests*. ASIP's intention is to check the robustness of incentives *even in case* the particular actor might have highly opportunistic interests that partly run counter to an effective and efficient service delivery. Incentive effectiveness in such a case will be achieved if sufficient rewards or sanctions are present in the existing governance system to make the actor realize that effective and efficient service delivery will be in his/her own best interest. This is what is meant by creating a "win-win-situation". The actor realizes that the best way to serve one's own interests is to serve the interests of the service provision agreement at hand.

Box M10-1: Implementing ASIP – The case of the "Neste System" in southern France (from MAINTAIN Case Study No. 2)

The "Neste System" is a system of storage reservoirs, canals, small rivers and irrigation schemes that is located in the region of Midi-Pyrénées, in southern France. The hilly landscape in that region stretches from the south to the north and is interspersed with a total of 17 small rivers and streams, which, owing to the morphological structure, only have extremely small water-catchment areas. As a result, water flow would, under normal conditions, not be possible all year round. To improve the availability of water, both for agricultural purposes and for drinking water supplies to the cities and local communities in this area, a link canal ("canal de la Neste") was built some time ago. This canal is fed by storage dams in the Pyrenees and carries water both to the river Neste and to the head of the other 17 small rivers and thus makes it possible to provide minimum flows of water even during the time of the year when these rivers would normally run dry.

The "Compagnie d'Aménagement des Coteaux de Gascogne" (CACG) is a semi-public company ("societé d'économie mixte") that is mandated by the state to promote water development in the region of Midi-Pyrénées. Amongst others its mandate comprises the maintenance of the mentioned system of the "canal de la Neste". The "client" of this maintenance service is the state, which wants to preserve the public infrastructure of the canal system for the future, but indirectly also the water users (for irrigation as well as municipal and industrial water supplies) who are the clients of various water delivery services. The maintenance service of the canal system is financed from different sources. First, are the water charges paid by the users. Second is a subsidy by the state to CACG for the service of maintaining minimum flow rates in the rivers. This subsidy is financed from a special water duty, which is a fee paid to the water agency by the users. The level of this subsidy, however, is linked to certain ideal hydrographic standards of water provision in the canal system, which are monitored by the state. Moreover, a de-facto subsidy is given in that the state has been financing a large-scale rehabilitation program for the entire Neste canal system before CACG took over the maintenance mandate.

The case is interesting for an ASIP exercise, an exercise carried out by the authors of this Guide after completion of the MAINTAIN study and without feedback from CACG. At the time of the study, CACG did not consider itself to be facing any maintenance problems worth mentioning. Moreover, it claimed to be one of the few large-scale, regional water management organizations that achieves full cost recovery in operating and maintaining its various sub-systems. Moreover, CACG regards itself explicitly as a service provider and has fully internalised the role. This was indicated clearly in its very positive incentive profile.

The essential steps needed to implement an ASIP are the following:

- Identify the type of service in question,
- Identify the actor, i.e. the organization, group or individual for which the ASIP is to be implemented,
- Discuss with representatives of the actor personal goals and strategies. In case this is not possible, assume such personal goals and strategies pursued by similar actors in similar situations,

Box M10-2: Implementing ASIP – The case of medium and large irrigation systems in Pakistan and India (Source: adapted from Ul Hassan, 1999, MAINTAIN Country Study No.2)

Both in Pakistan and India, irrigation and drainage are crucial for the economy. Some of the world's largest surface irrigation systems exist in Pakistan and India. Following the Green Revolution of the 1960's, many irrigation systems were extended and storage dams were constructed to provide increased and reliable water supplies. The major focus up to the 1970's had been to extend the physical infrastructure and few attempts were made to sustain the available facilities. The financial resources had been diverted to extend irrigation infrastructure, rather than to manage and maintain. Owing to increasing costs of new irrigation projects and increasing scarcity of water resources, in Pakistan the 1980's witnessed a shift in emphasis to the conservation of water through lining of tertiary canals and rehabilitating the primary and secondary canal systems through several programs.

However, in both countries, water delivery remained subsidized with no direct link between service and costs. Water-tax collection has tended to decline over time. The institutional environment fostered poor coordination and resulted in rendering official rules for water delivery and maintenance service provision impossible to enforce. System inefficiencies have led to various recent institutional reforms in the water sector. An example of one prominent and recent reform process is Andhra Pradesh, India (analysed with respect to service provision in MAINTAIN Case Study No.5).

The ASIP method employed in Case Study 5 is only a rapid assessment of the incentive situation of irrigation staff as it may have existed in many irrigation schemes prior to the reform processes. The example shows, that, from the standpoint of incentive effectiveness, there was no chance for a reasonable functioning of the maintenance service provision in these schemes.

Table M10-2. Actor-Specific Incentive Profile (ASIP) for maintenance service provision by CACG/France
(Supporting Document: MAINTAIN Case Study No.2)

Type of Service: Maintaining the hydraulic infrastructure in the Neste Canal System, Gascogne, France

Incentives: provided by the Service Arrangement CACG – Government

Actor for whom incentives are analysed: CACG/France

"Personal" goal/strategy of actor	Type of motivation	Type of incentives or disincentives provided by service agreement	Conditioning factor	Effectiveness of incentives for high quality maintenance
Secure financial "health" of CACG		▪ **Material incentives**		
	Minimize initial cost of maintenance for Neste Canal System	Implementation of special ex-ante rehabilitation program by government	Completion of rehabilitation prior to transfer of maintenance responsibility to CACG	high
	Earn maintenance reserves ("provision de maintenance")	User charges for supply of water in water courses to be used for reserve	User charges to be made available to CACG	high
	Earn additional subsidies	Provide subsidy for maintaining minimum flow in rivers	Level of subsidy linked to hydrographic standards of water provision	high
	Potential use of maintenance funds for other activities	Prescription of minimum expenditure for maintenance by government (disincentive)	Setting annual maintenance reserve for specific lower limit of expenditures	fairly high
		▪ **Immaterial incentives**		
Secure operational independence and high prestige for CACG	Conduct good maintenance but in own planning and implementation responsibility	Act as state concessionaire	Monitoring by the state via "CACG supervisory board"	high
	Temptation to do "gold plated" maintenance	Prescription of maximum expenditure for maintenance (disincentive)	Setting of annual maintenance reserve for specific upper limit of expenditures	fairly high

- Identify the types of motivation envisaged to result from incentives,
- Identify existing or envisaged material and immaterial incentives,
- Identify the conditioning factors that link particular incentives to the envisaged types of motivation,
- Asses the "incentive effectiveness", i.e. the estimated degree to which the identified incentives bring about the envisaged motivation.

In the following we present two examples for implementing ASIP, both of which are of the rapid appraisal type mentioned above. However they are meant to give a clear orientation for how to go about even in more detailed efforts to elaborate ASIP formats. The examples refer to cases that are described in the relevant MAINTAIN documents mentioned in the title of the figures. For those readers that do not have the opportunity to look through these papers, we give some short indications as to the services in question.

Table M10-3 Actor Specific Incentive Profile (ASIP) for maintenance service provision in many Indian/Pakistani irrigation schemes
(Supporting documents: MAINTAIN Country Study No.1, MAINTAIN Case Study No.5)

Type of Service: Maintaining the hydraulic infrastructure in agency-farmer managed irrigation schemes in India/Pakistan.
Incentives: Provided by government employment conditions and work rules.
Actors for whom incentives are analysed: Engineering staff of Irrigation Departments / Irrigation and Command Area Development Departments

"Personal" goal/ strategy of actor	Type of motivation	Type of official (dis-) incentives	Conditioning factor	Effectiveness of incentives
Increase material well being of self/family		**Material incentives**		
	gain monetary income	Salary	Level of salary linked to level of position, not to quality of service	low
	Improve monetary income	Promotion	Promotion dependant on examinations/ qualifications/years of service and political connections, not on quality of service	low
	Temptation to extract side payments for operation and maintenance services from farmers	Forbid rent seeking activities	Low level of transparency and accountability related to services of water delivery and maintenance. Leads to rent seeking possibilities and decreases quality of service	very low
	Temptation to extract side payments for maintenance / rehabilitation contracts	Forbid rent seeking activities	Low transparency of tendering and contracting. No external control/auditing	low
	Gain material or political rewards	Gain donor funds with rehabilitation needs	Donor funding only for rehabilitation, not for maintenance	low
		Immaterial incentives		
Gain status and prestige from work	Prefer "high status" engineering work (design, construction)	No or low sanctioning of deferred maintenance	No voice for negatively effected farmers	low
	Prefer "high status" work location in towns	Promotion with transfer to town	High quality maintenance service requires frequent presence in the field	low

References and Literature

A. Main references: The MAINTAIN-papers

Series of case studies

No. 1 *Institutional Analysis of Maintenance in the Lower Seyhan Irrigation System, Turkey.* Waltina Scheumann and Artur Vallentin, 1999

No. 2 *Maintenance as a Service Provision in Irrigation – The Example of the "Neste System" in Southern France –.* Walter Huppert and Christian Hagen, 1999

No. 3 *Institutional Analysis of Water Delivery and Maintenance Service Provision in Irrigation: The Example of the Jordan Valley*. Walter Huppert and Klaus Urban, 1999

No. 4 *Shifting Public and Private Roles in Maintenance Service Provision: California's Central Valley.* Walter Huppert, Mark Svendsen and David Cone, 2000

No. 5 *Incentive Creation for Irrigation System Maintenance and Water Delivery: The Case of Recent Reforms in Andhra Pradesh.* Mark Svendsen and Walter Huppert, 2000

No. 6 *Institutional Analysis of Maintenance Service Provision in the Alto R'o Lerma Irrigation District, Mexico.* Klaus Urban, Philippus Wester and Wim H. Kloezen, 2000 (Cooperation GTZ – IMWI)

No. 7 *The Case of a New Water Fee System in the Republic of Macedonia.* Thilo Hatzius, 2000

Series of thematic papers

No. 1 *Irrigation Maintenance Strategies: A Review of the Issues.* Ian Carruthers† and Jamie Morrison, 1994

No. 2 *The Neglect of Maintenance in Project Planning: What is the Scope for Fine Tuning Appraisal Procedures?* Ian Carruthers† and Jamie Morrison, 1994

No. 3 *Improving Maintenance in Irrigation: External Roles in Strategic and Operational Change*. Mark Svendsen, 1994

No. 4 *Maintenance, Sustainability, and Irrigation Management Transfer*. Mark Svendsen, Ian Carruthers† and Thomas Buhl-Böhnert, 1994

No. 5 *Institutional Reform Options for Overcoming the Underfinancing of Irrigation Maintenance in Less Developed Countries*. Douglas L. Vermillion, 1999
No. 6 *Property Rights and Maintenance of Irrigation Systems*. Ruth Meinzen-Dick, 2000 (Cooperation GTZ – IFPRI)
No. 7 *Irrigation Management Transfer: Changing Complex Delivery Systems for O&M Services*. Walter Huppert, 1997
No. 8 *Using Asset Management Techniques for Condition and Performance Assessment of Irrigation and Drainage Infrastructure*. Martin Burton, 2000
No. 9 *Rent seeking in irrigated agriculture: institutional problem areas in operation and maintenance*. Jochen Renger and Birgitta Wolff, 2000
No. 10 *Governance by Contractual Rules – Improving Service Relations in Irrigation*. Birgitta Wolf and Walter Huppert, 2000
No. 11 *Optimal Maintenance in Irrigation*.(4 Papers) Mark Svendsen and Walter Huppert; Gilbert Levine; Klaus Urban; David G. Cone, 2000
No. 12 *Incentives for Financing the Maintenance of Irrigation and Drainage Systems*. Paul J.M. van Hofwegen, 2000 (Cooperation GTZ – IHE)

Series of country papers

No. 1 *Maintenance in Turkish Irrigation and Drainage Systems.* Waltina Scheumann, 1999
No. 2 *Maintenance in Pakistani Irrigation and Drainage Systems.* Mehmood Ul Hassan, 1999 (Cooperation GTZ-IWMI)

Accompanying GTZ-publication No. 263

Huppert, W. and K. Urban, 1998 *Analysing Service Provision – Instruments for development cooperation illustrated by examples from irrigation,* GTZ

B. Additional references

Bromley, D.W., 1991 Environment and economy. Property rights and public policy. Cambridge: Blackwell.

Burton, M. and R.P. Hall, 1999 Asset Management – Addressing the issue of serviceability. Irrigation and Drainage Systems, Kluwer Academic Publishers, November

Cornish, G. and J. Skutsch, 1997 *A Procedure for Planning Irrigation Scheme Rehabilitation.* Report OD/TN 84, HR Wallingford, Wallingford, UK.

El-Askari, K.M.S., 2000 *A Methodology for Expenditure Planning of Irrigation Infrastructure Using Hydraulic Modelling Techniques.* Unpublished Thesis, University of Southampton, UK.

FAO, 1993 *The State of Food and Agriculture; Water Policies and Agriculture* Rome.

GICC, 1998 *Guidelines for Irrigation Canal Control.* Sir William Halcrow and Partners, Swindon, UK and Institute of Irrigation and Development Studies, University of Southampton, UK

Glennie, E.B., P. Timbrell and J.A. Cole, 1991 *Manual of condition assessment for flood defences.* WRc Engineering, Swindon, UK.

Herder-Dorneich, Ph., 1983 *Der Sozialstaat in der Rationalitätenfalle* Kohlhammer

Herder-Dorneich, Ph., 1986 *Theorie der Sozialen Steuerung* Nomos Verlagsgesellschaft, Baden-Baden

Huppert, W., 2000 *Governing Irrigation Service Delivery in Water Scarce Situations* ICID Journal, Vol 49, No.1

Huppert, W. and K. Urban, 1993 *Service Analyses in Water and Soil Associations – Taking the Nienburg Weser Association as an Example* In: Zeitschrift für Bewässerungswirtschaft, Vol 28, No. 2, 1993

IIS 1995 *Asset management procedures for irrigation schemes – Final Report.* Institute of Irrigation Studies, University of Southampton, Southampton, UK.

Karunasena, H., 1993 *Mobilizing Farmers' Resources for Maintenance of Irrigation Schemes* In: Papers presented to the Asian Regional Symposium held in Beijing, PRC, 24.27 May. HR Wallingford, Wallingford, UK.

Krause, D. and V. Temple, 1988 *Maintenance Management* In: Water Systems Operation and Maintenance Workshop, Session Notes. Denver, CO.

Mody, A., 1996 *Infrastructure Delivery* EDI Development Studies, The World Bank

Olson, M., 1968 *The Logic of Collective Action* New York: Schoken Books

Ostrom, E. L. Schroeder and S. Wynne, 1993 *Institutional Incentives and Sustainable Development* Westview Press

Richter, R. and E. Furubotn, 1996 *Neue Institutionenökonomik – Eine Einführung und kritische Würdigung* J.C.B. Mohr (Paul Siebeck) Tübingen

Savas, E.S., 1990 *Privatization : the key to better government.* Chatham House Publishers, Chatham, N.J.

Skutsch, J.C., 1998 *Maintaining the Value of Irrigation and Drainage Projects,* Report OD/TN 90, HR Wallingford, Wallingford, UK.

Svendsen, M., 2000 *Irrigation Management Institutions in the Western United States: an Overview.* Mimeo. Paper prepared for the World Bank Institute

Thoreson, B.P., D.C. Slack, R.P. Satyal and R.S.S. Neupane, 1997 *Performance-based Maintenance for Irrigation Systems* Journal of Irrigation and Drainage Engineering 123 (2):100-105

UNEP, 1992 *Saving our Planet* Nairobi.

Wolff, Birgitta, 1995 *Organisation durch Verträge.* Deutscher Universitätsverlag.

World Bank, 1994a *A Review of World Bank Experiences in Irrigation.* Report No. 13676, Washington

World Bank, 1994b *Governance: The World Bank's Experience.* Report No. 12094, Washington

C. Recommended further reading

Bandaragoda, D.J., 2000 *A Framework for Institutional Analysis for Water Resources Management in a River Basin Context.* IWMI Working Paper no. 5

Bandaragoda, D.J., 1998 *Need for Institutional Impact Assessment in Planning Irrigation System Modernization* IWMI, Colombo, Sri Lanka

Bruns, B.R. and R. Meinzen-Dick, 2000 (eds.) *Negotiating Water Rights,* IFPRI, Vistaar Publications, New Delhi

Dinar, A. and A. Subramanian, 1997 *Water Pricing Experiences* World Bank Technical Paper No. 386

Herder-Dorneich, Ph., 1986 *Theorie der Sozialen Steuerung* Nomos Verlagsgesellschaft, Baden-Baden

Huppert, W. and K. Urban, 1998 *Analysing Service Provision – Instruments for development cooperation illustrated by examples from irrigation* GTZ Publication Series No.263

Malano, H.M. and P.J.M. van Hofwegen, 1999 *Management of Irrigation and Drainage Systems – A Service Approach* IHE Monograph 3, Balkema Publishers Rotterdam/Brookfield

Murray-Rust, D. and W.B. Snellen, 1993 *Irrigation System Performance – Assessment and Diagnosis* IIMI, Colombo, Sri Lanka

Olson, M., 1968 *The Logic of Collective Action* New York: Schoken Books

Ostrom, E. L., 1990 *Governing the Commons – The Evolution of Institutions for Collective Action* Cambridge University Press

Ostrom, E.L., 1992 *Crafting Institutions for Self-Governing Irrigation Systems.* San Francisco, Calif.: Institute for Contemporary Studies Press.

Ostrom, E. L. Schroeder and S. Wynne, 1993 *Institutional Incentives and Sustainable Development* Westview Press

Pratt, J.W. and R.J. Zeckhauser, 1991 *Principles and Agents: The Structure of Business* Harvard Business School Press

Richter, R. and E. Furubotn, 1996 *Neue Institutionenökonomik – Eine Einführung und kritische Würdigung* J.C.B. Mohr (Paul Siebeck) Tübingen

Savas, E.S., 1990 *Privatization : the key to better government.*
Chatham House Publishers, Chatham, N.J.

Skutsch, J.C., 1998 *Maintaining the Value of Irrigation and Drainage Projects,* Report OD/TN 90, HR Wallingford, Wallingford, UK.

Subramanian, A., N.V. Jagannathan, R. Meinzen-Dick, 1997 *User Organizations for Suistainable Water Services World Bank Technical Paper No. 354*

Svendsen, M., 2000 *Basin Management in a Mature Closed Basin: The Case of California's Central Valley.* Case Study prepared for the International Workshop on Integrated Water Management in Water Stressed River Basins Loskop Dam, South Africa, 16–21 Oct.

Vermillion, D.L. and J.A. Sagardoy, 1999 *Transfer of Irrigation Management Services – Guidelines* FAO, Rome

Wolff, Birgitta, 1995 *Organisation durch Verträge.* Deutscher Universitätsverlag.

World Bank, 1994b *Governance: The World Bank's Experience.* Report No. 12094, Washington

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