CHAPTER 1

INTRODUCTION

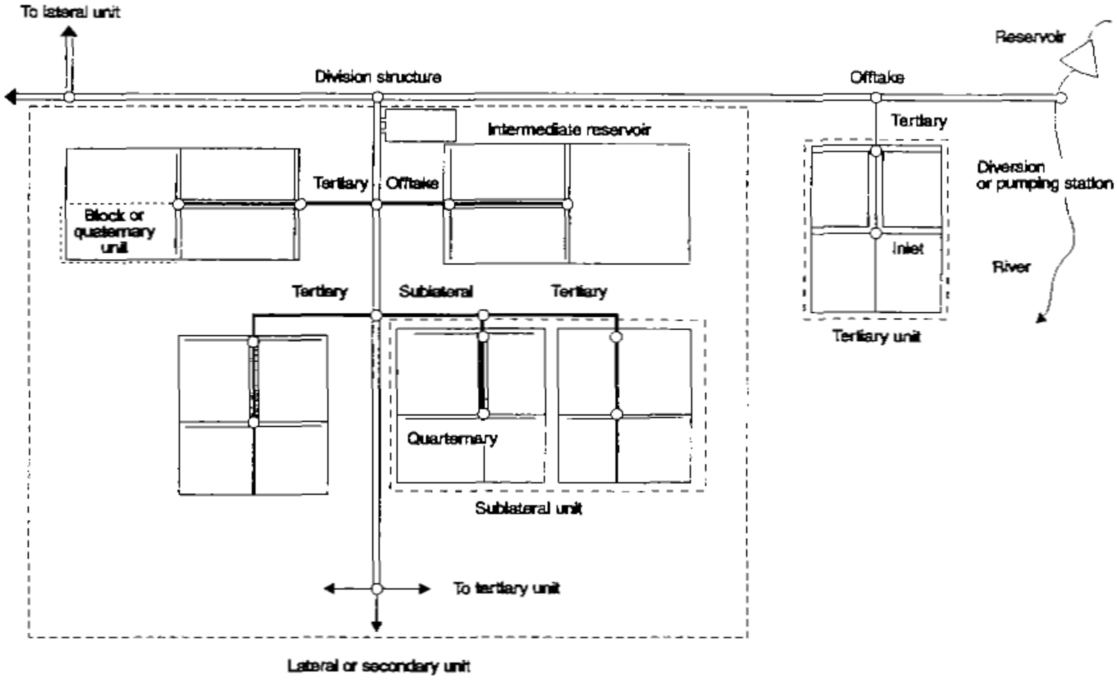
1.1 Introduction

The standard of maintenance of irrigation and drainage is poor in many irrigation systems throughout the world. Inferior management of those weeds growing in the channel, aquatic weeds leads to a number of economic, social and environmental problems:

1. Aquatic weeds decrease flow velocities and cause reduced discharge capacity and increased siltation, leading to losses of farm production and agricultural land, by:
   - shortages of irrigation water, especially at the tail of canals
   - waterlogging from poorly performing drains.
2. Weeds provide a habitat for vectors of disease (such as schistosomiasis and malaria) and other pests (for example, rats and snakes) affecting human health and crop production.
3. Weeds may spread from the canal into irrigated fields, reducing crop yields.
4. Inefficient weed control causes wastage of scarce resources and environmental damage:
   - unproductive inputs in existing maintenance work including labour, machinery and chemicals
   - foregone outputs leading to low crop production
   - health hazards to workers and farmers from herbicides and schistosomiasis.
5. A vicious circle develops of poor water supply, poor agricultural productivity, farmers' reluctance to pay water charges and underfunding of maintenance, further weakening infrastructure and management
6. There is a failure to realise the potential uses of weeds, for example as manures, feedstuffs and building materials.

In this book we address these problems and seek to develop a new conceptual approach to the systematic management of aquatic and bankside weeds, based on interdisciplinary research which combines ecological, engineering, institutional and economic perspectives.

Management is used both in the technical sense of weed control, and in the institutional sense of managing operations. The two meanings are combined in the concept of weed management as a service which is provided (usually by an irrigation agency to farmers and the wider society) to control weeds within the irrigation and drainage system This includes canals and drains of all types and sizes, and intermediate or night storage reservoirs, but not the fields served by the system.



Source: Adapted from Bos (1985)

Figure 1.1. The hierarchy of irrigation and drainage channels: primary, secondary, tertiary and quaternary canals and drains

We can then consider ways to improve the effectiveness of the service, following the approach of Murray-Rust and Snellen (1993), in terms of:

- the degree to which the service meets the need for weed control (the level of service);
- the efficiency with which the organisation uses resources in meeting these needs.

As explained later in this chapter, the level of service includes both hydraulic and environmental criteria. Resources include water, finance, machinery and labour.

The book focuses on irrigation systems within tropical and sub-tropical areas and is based in large measure on experiences gained through work in Africa which is described in Chapter 2. The problems caused by weeds in irrigation and drainage channels are described in Chapter 3, and guidelines on the identification of feasible control options are presented in Chapter 4.

The next three chapters cover the selection of an appropriate control programme. Chapter 5 provides guidance on the setting of maintenance policy, Chapter 6 covers the methods of preparing a maintenance programme. Chapter 7 shows how economic tools can be used to select an efficient option, and in Chapter 8 we consider the incorporation of the weed control programme within an irrigation management programme.

Chapter 9 deals with the institutional aspects of management and the conclusions are presented in Chapter 10.

1.2 Types of irrigation system

This book is concerned with irrigation and drainage systems which use open channels for delivery of irrigation water and/or for removal of drainage water. Examples of these channels are shown in Plate 1.1. Most surface irrigation systems come into this category (though some use pipelines instead of open channels for irrigation or drainage), and it includes the open channel systems associated with some sprinkler irrigation and micro-irrigation (trickle) systems.

Irrigation and drainage channels are commonly described using the hierarchy: primary, secondary, tertiary and quaternary canals and drains, as shown in Figure 1.1.

Also included in this study are intermediate reservoirs (or night storage reservoirs) (Plate 1.2) which are placed within the canal system to provide operational flexibility. The intermediate reservoir is supplied at a steady rate from the upstream canal system, but then delivers water to users on a more convenient schedule or demand basis. Night storage reservoirs are a particularly common type of intermediate reservoir, which is filled on a continuous basis (day and night) from upstream, but delivers water during the day only.

1.3 Recent trends in irrigation development

There was a major expansion of world-wide irrigated area in the 1960s and 1970s, with the construction of new irrigation schemes supported by major funding agencies.

Conditions for new irrigation projects however have been seen as less favourable since the mid 1970s because of concern about FAO (1993):

- increased construction costs compared to falling crop prices (especially of cereals);
- environmental and social impact of irrigation and water resource development projects;
- disappointing performance of many irrigation projects, because of poor scheme conception, inadequate construction and implementation or ineffective management.

With a shift in aid agencies' priorities, governments have come under international pressure to reduce irrigation expenditure which, as a major part of government agriculture budgets, has become seen as a drain on public funds. Past borrowing for irrigation has also contributed to high levels of national debt, with costly servicing requirements.

Food and Agriculture Organisation (FAO 1993) refers to a shift from a 'supply-side management' of irrigation to a 'demand-side management' strategy, with a reduction of the role of government and an increased role for users. To provide a new institutional framework for the changed strategy, irrigation projects and programmes have included the creation and strengthening of water user associations (WUAs) and the turnover of management responsibilities to WUAs or private companies. There are limits, however, to the financial and technical responsibilities which rural communities in low-income countries can undertake satisfactorily. It is interesting to compare WUAs with agricultural input supply and marketing cooperatives. These have had a mixed record which has led to a poor reputation for WUAs and a reduced role in agricultural development in many countries.

A review of devolution of management in public irrigation systems in the mid-1990s found positive and encouraging experiences in Chile, Mexico, China, Columbia, Nepal and Indonesia, but stressed the need for development of a service culture in irrigation agencies, which is not necessarily easier to achieve by privatisation than by public sector management reform (Turral 1995). Another interesting finding was that:

"Evidence in the USA, Australia, the Philippines and other countries is starting to indicate that farmers may not necessarily be better managers than the state, particularly with respect to maintaining and financing repairs to the physical infrastructure. Desire for the minimum possible water price seems to neglect longer-term considerations or implicitly assumes that the government will always step in to finance deferred maintenance."

The turnover of schemes to local communities and privatisation do not remove the need for efficient and effective management of weeds in irrigation and drainage channels. Perhaps turnover and privatisation are better regarded as possible changes or threats to existing irrigation agencies which might encourage managers and technical staff to improve their own practice.

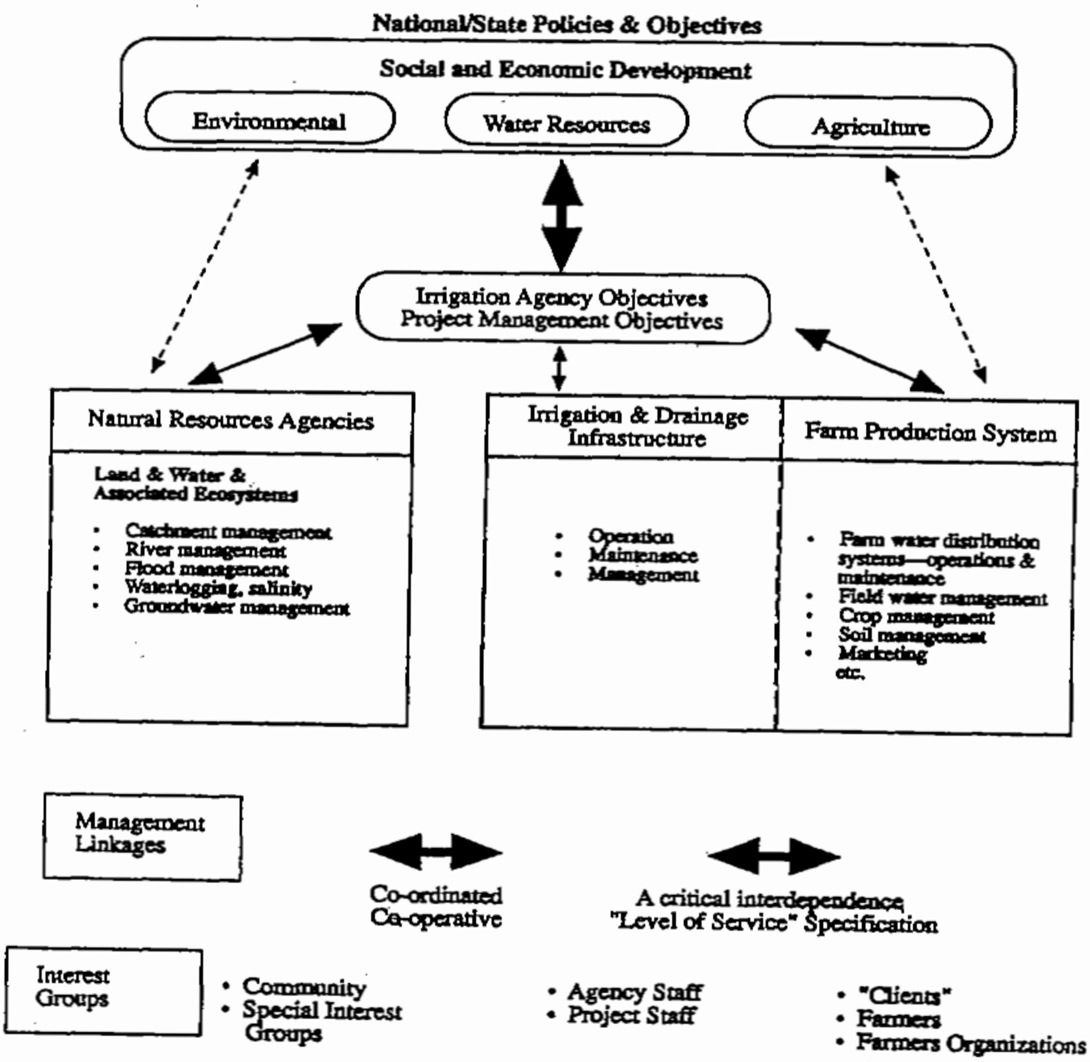


Figure 1.2. Sustainable development and management: management linkages

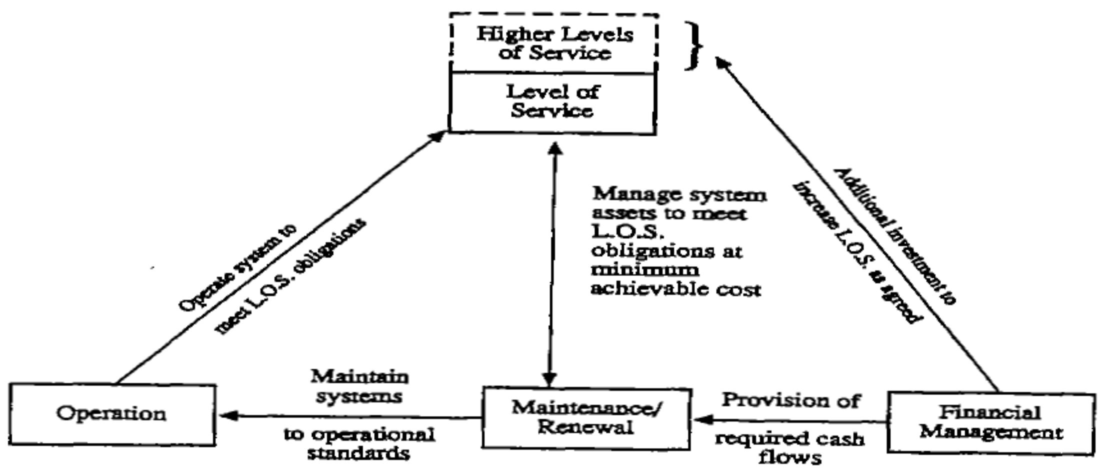
1.4 Irrigation management issues and approaches

During the 1980s and 1990s, widespread concern about poor irrigation management has been supported by detailed research. (An early example of this is a study for the World Bank by Bottrall (1981)). A comprehensive analysis from south Asia (Chambers (1988), stressed the need for an interdisciplinary "whole systems" approach including physical, bio-economic, human and environmental domains, and both space and time dimensions (Chambers 1988). It also identified five major blind spots or gaps in previous work, which helped explain past poor performance and provided the key to improved canal irrigation management:

1. main system management (the central gap)
2. canal irrigation at night
3. farmers' actions above the outlet
4. managers and motivation
5. methods and approaches for diagnostic analysis.

Subsequent research has addressed some of these issues, and we hope that this book will itself throw some light on the first and last blind spots.

Business management approaches have also been applied to irrigation systems in recent years, as to other public services, considering for example performance assessment (e.g. work by Small and Svendsen (1992) and Murray-Rust and Snellen (1993)) and strategic business planning (e.g. an ODA research project on Asset Management Procedures for Irrigation Schemes by IIS (1994)). A common finding is that these approaches require data which have not been collected routinely in the past. One of the challenges we face in writing this book is to develop procedures which are feasible for irrigation managers to introduce and sustain.



Notes:

1. For a specific Level of Service (L.O.S.), there will be an associated identifiable cost.
2. In poorly managed systems, improvements in L.O.S. can be achieved by improving management processes and control (often by some additional costs and by re-ordering financial priorities).
3. In well-managed systems, substantial increase in L.O.S. will generally require significant additional investment.

Figure 1.3. System management objectives

This challenge is being considered by the International Commission on Irrigation and Drainage (Constable 1993), which drafted the management context of irrigation and the objectives of irrigation system management (Figure 1.2 and 1.3). The concept of a Level of Service is used, representing a specific set of objectives chosen for the circumstances. The term Standard of Service is a similar concept used by the UK water industry, including by the Environment Agency for management of drainage channels (Birks *et al.* undated).

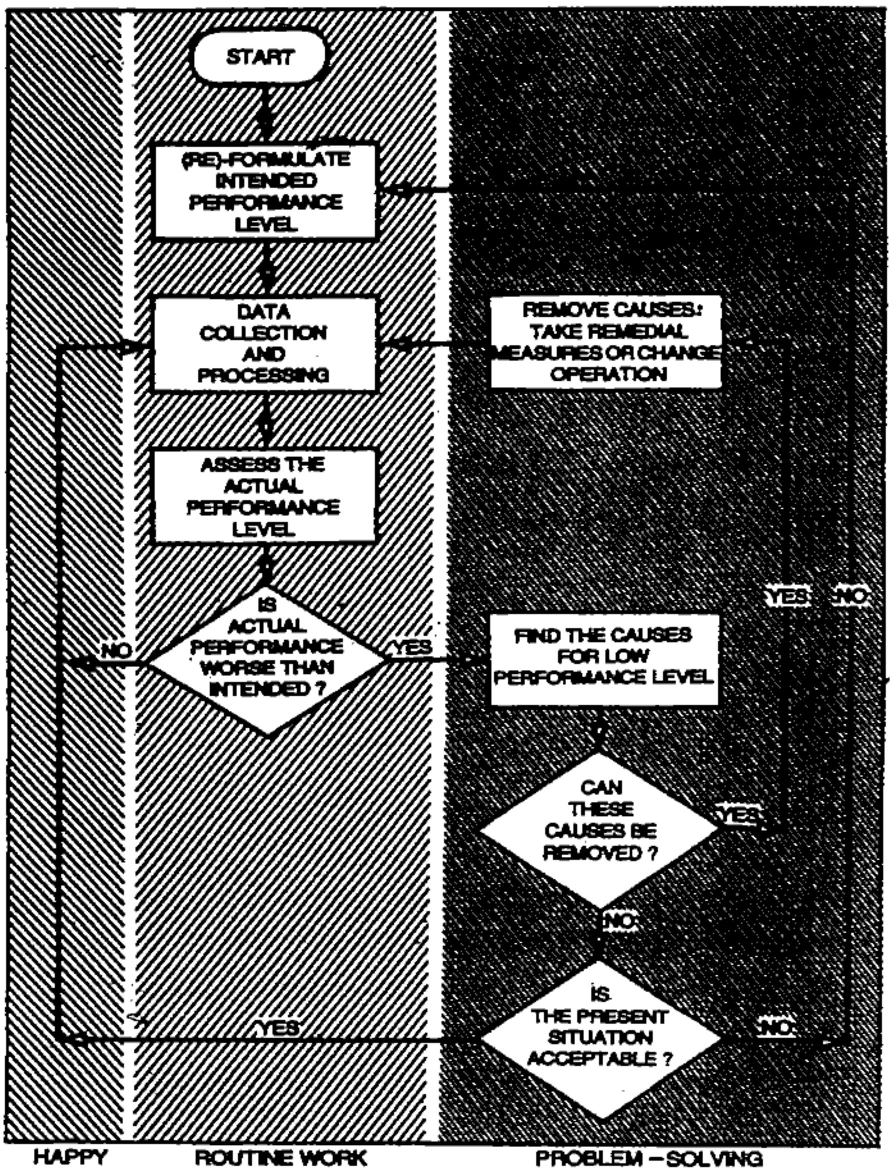


Figure 1.4. A simple flow chart of irrigation water management

The approach developed below considers an appropriate level of service which would be followed in planning maintenance work for irrigation and drainage channels, specifically weed management. This level of service would combine such factors as hydraulic performance, reliability/risk, cost effectiveness from financial and economic perspectives, and environmental and social impacts.

Wolters and Bos (199) provide a simple flow chart of the management process (Figure 1.4), which illustrates the importance of assessing performance against intended (target) levels and directing actions to improve performance. The next step is to identify appropriate objectives of irrigation and weed management, and specific related performance indicators to which target values can be set. These objectives, performance indicators and targets would constitute the level of service.

The overall aim of irrigation will depend on the specific organisation or project being considered, and the analytical perspective. Chambers (1988) suggests "optimising human well-being" to encompass the many different possibilities. For our purposes it is helpful to expand this into the following aim:

Optimising human well-being by maximisation of agricultural benefits through the controlled delivery and removal of water, while safeguarding the environment, and by making efficient use of water and other resources.

Using the guidelines

Aquatic weeds can create a significant problem for irrigation system managers and individual landowners alike. This problem is one of the factors which prevents irrigation and drainage systems achieving their optimal production. The solution to the problem relies on the determination of the most appropriate maintenance strategy planned over a number of years. This strategy needs to combine recognition and an understanding of the aquatic weeds (i.e. identification of the problem species and the stage of succession which the vegetation has reached (see Section 3.6.2)), suitable control strategies, the engineering demands of a given channel (i.e. the level of service requirement) and the economic implications. The inter-relationship of these different components is summarised in the flow diagram in Figure 1.5 (see page 9).

The process of working through this flow diagram (Figure 1.5) will not only enable an irrigation system manager or landowner to choose an appropriate and cost-effective solution but it will also encourage a greater understanding of the system. For example, careful consideration must be given to deployment of labourers and machinery, and aquatic weed management can be better integrated with desiltation maintenance.

References

Birks, C.J., Pickles, M.L., Bray, C.W. and Taylor, K. (undated). Standards of service for flood defence: a framework for planning and monitoring.

Bottrall (1981). Comparative study of management and organisation of irrigation projects. World Bank Staff Working Paper No. 458, World Bank, Washington.

Chambers, R. (1988). Managing canal irrigation. Practical analysis from South Asia. Cambridge University Press, Cambridge.

Constable, D. (1993). Draft revisions to World Bank Technical Paper No. 99. Paper presented to ICID Working Group on Operation, Maintenance and Management, The Hague.

FAO (1993). The State of Food and Agriculture. FAO, Rome.

IIS (1994). Asset management procedures for irrigation schemes Final Report. Institute of Irrigation Studies, University of Southampton, UK

Murray-Rust, D.H. and Snellen W.B. (1993). Irrigation system performance assessment and diagnosis. International Irrigation Management Institute, Sri Lanka

Small and Svendsen, (1992). A framework for assessing irrigation performance. Working Papers on Irrigation Performance No.1. Washington D.C., International Food Policy Research Institute.

Turral, H. (1995). Devolution of management in public irrigation systems: cost shedding, empowerment and performance. Working Paper no 80, Overseas Development Institute, London

Wolters and Bos (1990). Irrigation performance assessment and irrigation efficiency. International Institute for Land Reclamation and Improvement. 1989 Annual Report. Wageningen.

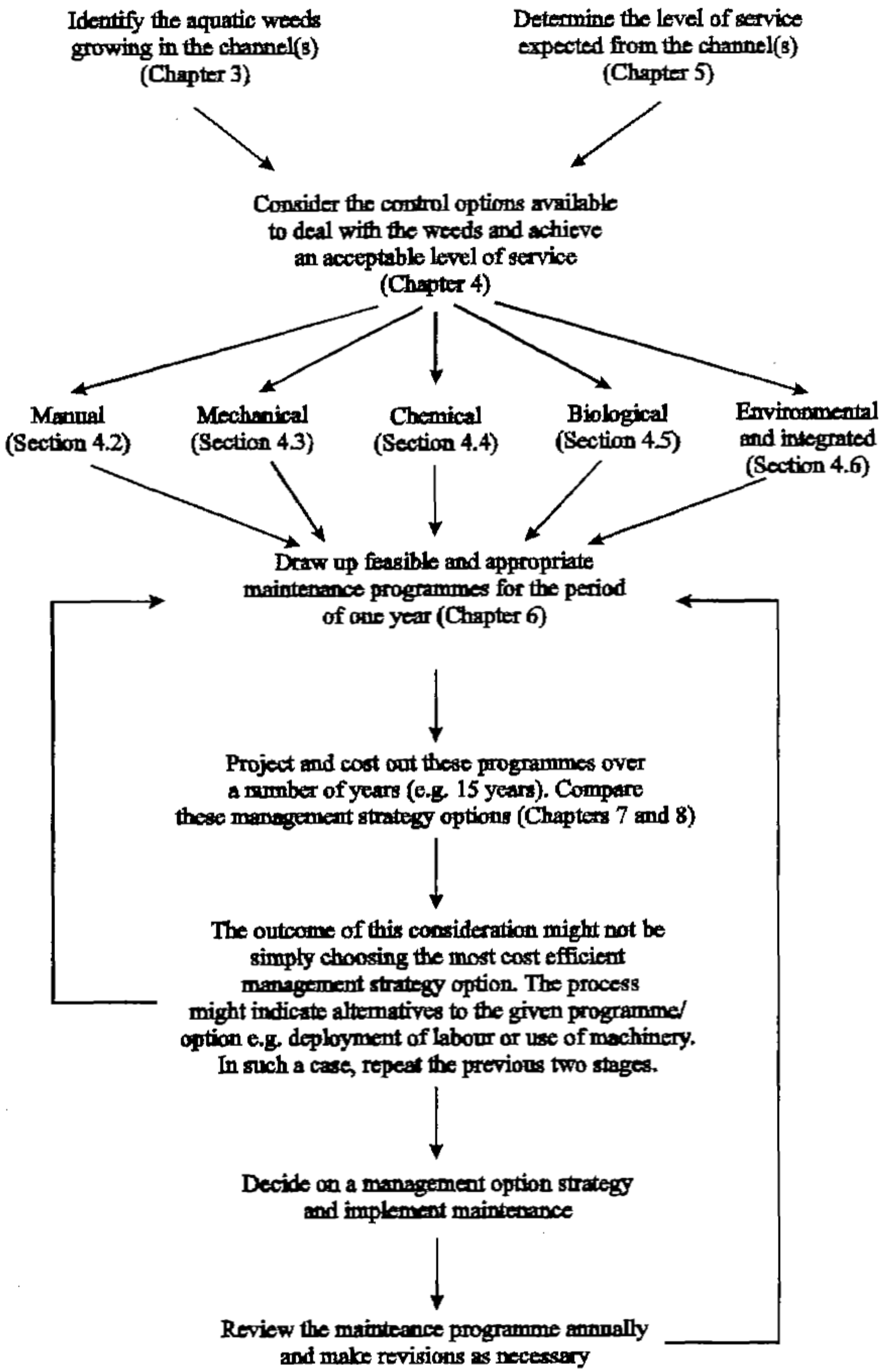


Figure 1.5. Process for determining aquatic weed maintenance strategy

Plate 1.1 Examples of irrigation and drainage channels experiencing differing degrees and types of aquatic weed problems: (a) and (b) Chisumbanje Estate, Zimbabwe; (c) Mwea Irrigation Settlement Scheme, Kenya, and (d) Hadejia Jama'are River Basin Irrigation Scheme, Nigeria.

Plate 1.2 Example of intermediate reservoir, Triangle Estates, Zimbabwe.