Chapter 4

Main problems in a canal network

4.1 INTRODUCTION

This chapter looks at problems which are frequently encountered in irrigation canal systems. Some of these are described in detail. The last section of this chapter explains why regular inspection of the system is required.

The main problems that can be found in an irrigation canal network include:

- limited amounts of water available at the water source;
- high water consumption in fields close to the water source resulting in water shortages at the tail end of the scheme;
- illegal manipulation of canals and structures;
- siltation;
- plant growth;
- water losses;
- frequent overtopping; and
- low water levels due to canal erosion.

Some of these problems may be caused by sub-optimal management and organization within the scheme, and Training Manual 10 in this series will cover that subject.

Bad design or bad construction may also be the cause of sub-optimal functioning of a scheme. A canal may be too small to supply enough water to irrigate the area served by the canal, and if the discharge needed is supplied to such a canal, it will be excessive and water will overtop. Also the water level in a canal may have been wrongly determined, and if it is too low water may not enter the fields by gravity. Check structures or even pumps will then be needed to supply the fields with sufficient water.

If the minimum required free board levels are not respected, canals can easily overtop in emergencies.

Canal slopes which are too steep may suffer erosion from high flow velocities. When construction materials are not well chosen, canals may collapse.

Lack of maintenance of the canal network will also cause severe problems, which are discussed later, in Chapter 5.

4.2 TECHNICAL PROBLEMS

Three of the problems mentioned above, and which are of a technical character, are described below in detail: water losses; overtopping; and canal erosion.

4.2.1 Water losses

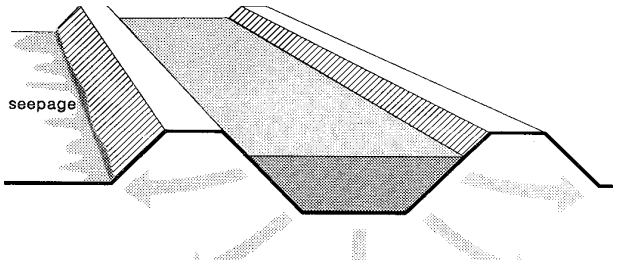
A well designed and constructed canal system transports water from the source to the farmers fields with a minimum amount of water loss. However, water losses will occur and can seriously reduce the efficiency of water delivery. Water may be lost by seepage, leakage, or both.

Seepage

Water that seeps through the bed and sides of a canal will be lost for irrigation. This so-called 'seepage loss' can be significant where a canal is constructed from material which has a high permeability: water seeps quickly through a sandy soil and slowly through a clay soil, and so canals constructed in sandy soils will have more seepage losses than canals in clay soils.

The results of seepage through the sides of a canal can sometimes be very obvious, such as when fields adjacent to a canal become very wet, and even have standing water (See Figure 22).

FIGURE 22
Canal with seepage water at the toe of the canal embankment



Seepage loss through the canal bed is difficult to detect because water goes down and does not appear on the nearby ground surface. Seepage can be reduced by:

- reinforcing the canal bank (See Section 5.3), or
- sealing or lining the canal bed and sides (See Chapter 6).

Leakage

Water may also be lost for irrigation by leakage. This water does not seep, but flows through larger openings in the canal bed or sides.

Leaks can develop in several ways:

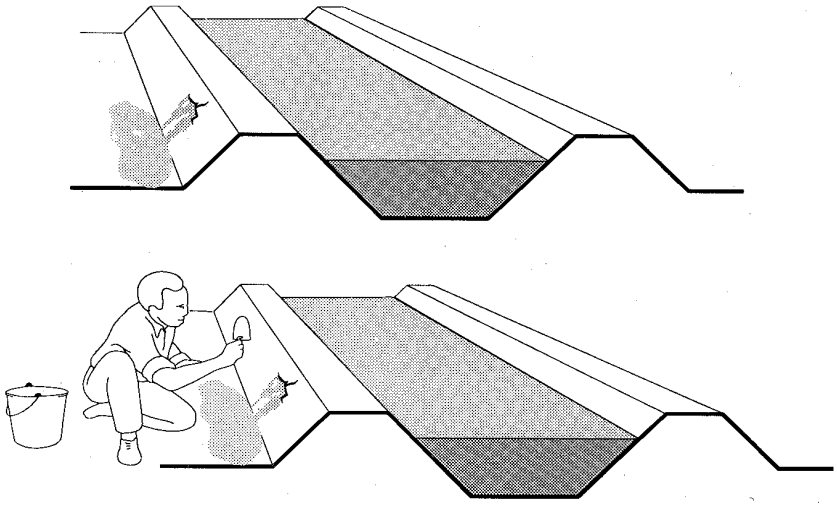
- by rat or termite holes in a canal bed or sides;
- eroded and washed canal bank;
- small tunnels started by seepage water in a badly compacted or sandy section of a canal bank;
- seepage around structures, leading to severe leakages;
- gates which are not tightly sealed;
- cracked concrete canal linings, or joints that are not tightly sealed; or
- torn asphalt or plastic lining.

Leakage often starts on a small scale, but the moment that water has found a way through a canal embankment a hole will develop through which water will leak. If the leakage is not stopped in time, the tunnel becomes larger and the canal bank may be washed away at a certain moment. In the case of a lined canal, the canal foundation may be undermined after some time and the canal will collapse.

Serious leakage can be avoided when the canal system is inspected frequently and when repairs are carried out immediately. The longer a hole or crack is left, the larger it will become.

Figures 23 and 24 show that quick action can save time and money.

FIGURE 23
A crack in a canal bank is repaired soon after it has been observed



In Figure 23, a small hole in a canal bank is repaired soon after it has been observed. In Figure 24, no attention has been paid to the leak, and, after some weeks, part of the canal bank has been washed away by the continuously leaking water. More time and money is needed to repair the canal in this case.

Repair of a leak is described in Section 5.4.

4.2.2 Overtopping

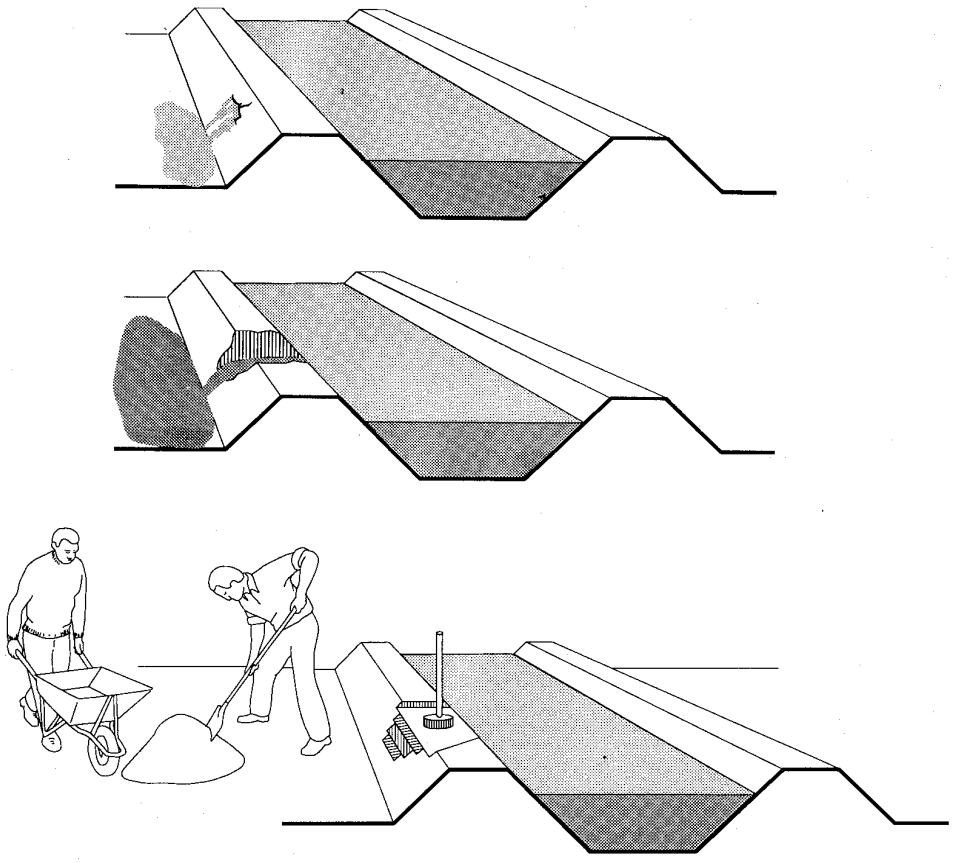
Water in a canal may rise unexpectedly due to several reasons:

- the incoming flow through the canal offtake may be much greater than the canal capacity;
- obstacles such as stones, blocks or plant growth in the canal may dam up the water;
- outlets from a canal may be closed which should be open;
- rain or other water may be draining into the irrigation canal; or
- farmers may make temporary weirs to raise the water level.

If no action is taken, the water level can reach the top of the canal banks and overtop. See Figure 25.

Overtopping causes erosion of the canal banks and may lead to serious breaches. It can be avoided by improving the operation of the system. Discharges should be limited and gates should only be closed and opened according to the planned schedule. To prevent overtopping, which can happen even in the best irrigation systems, a spillway - also called an emergency

FIGURE 24
Delayed repair of a leakage



outlet - can be installed in the canal bank so that excess flow can be spilled without harming the canal. See also Section 5.5, and Training Manual 8: *Structures*.

4.2.3 Canal erosion

The sides and bed of an unlined canal are sometimes badly attacked by scouring water. This process is called erosion. Canal bends and sections downstream of structures in particular are susceptible to erosion, since local flow velocities can be very high and the direction of flow changes suddenly, causing turbulence.

The inner side slopes of a canal which are too steep or which are not well compacted, may slide. The soil will be washed away by the flowing water and the canal will erode if the flow velocity is excessively high.

Figure 26 shows an eroded canal. The original and the actual cross-section can be clearly seen. The embankments have collapsed and the cross-section no longer has its original shape: it has become irregular. The canal banks have become smaller and the bed is wider than before. As a consequence, more water is needed to fill the canal and to attain the water level required, and there is more danger of a breakdown of the narrowed banks. When the embankments of a canal are not very solid, erosion can result in leakage.

FIGURE 25
Overtopping of a canal bank

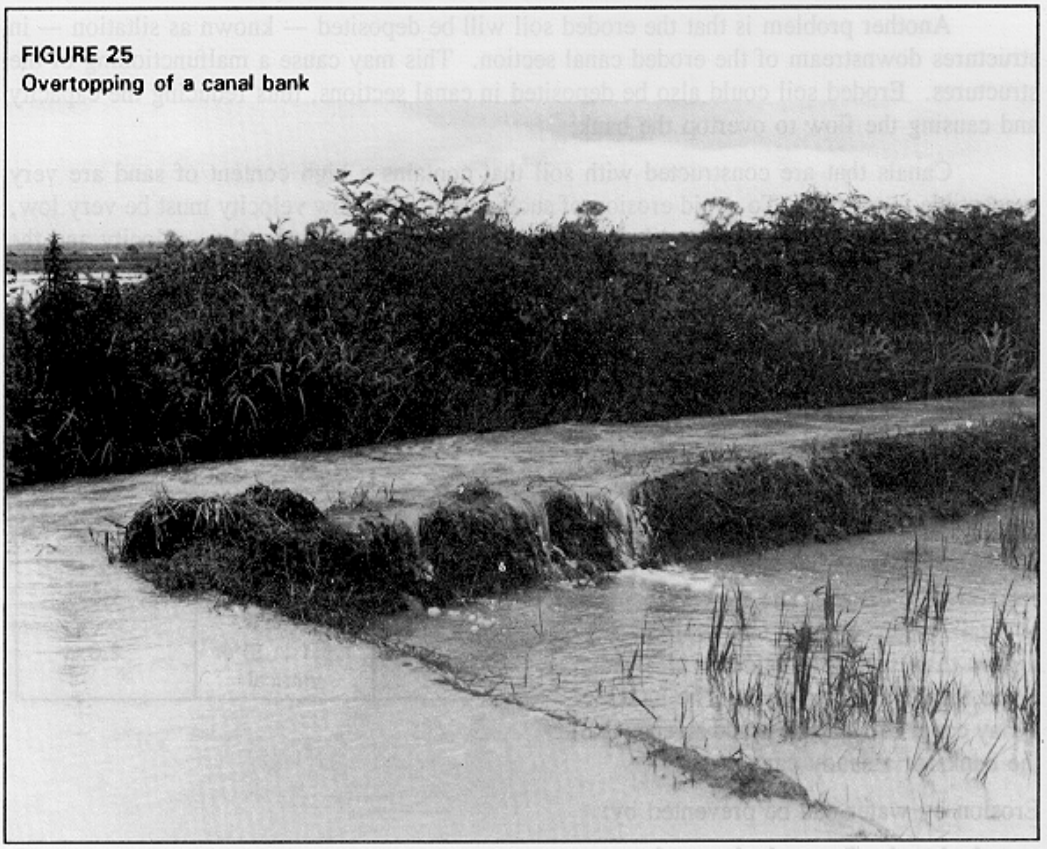
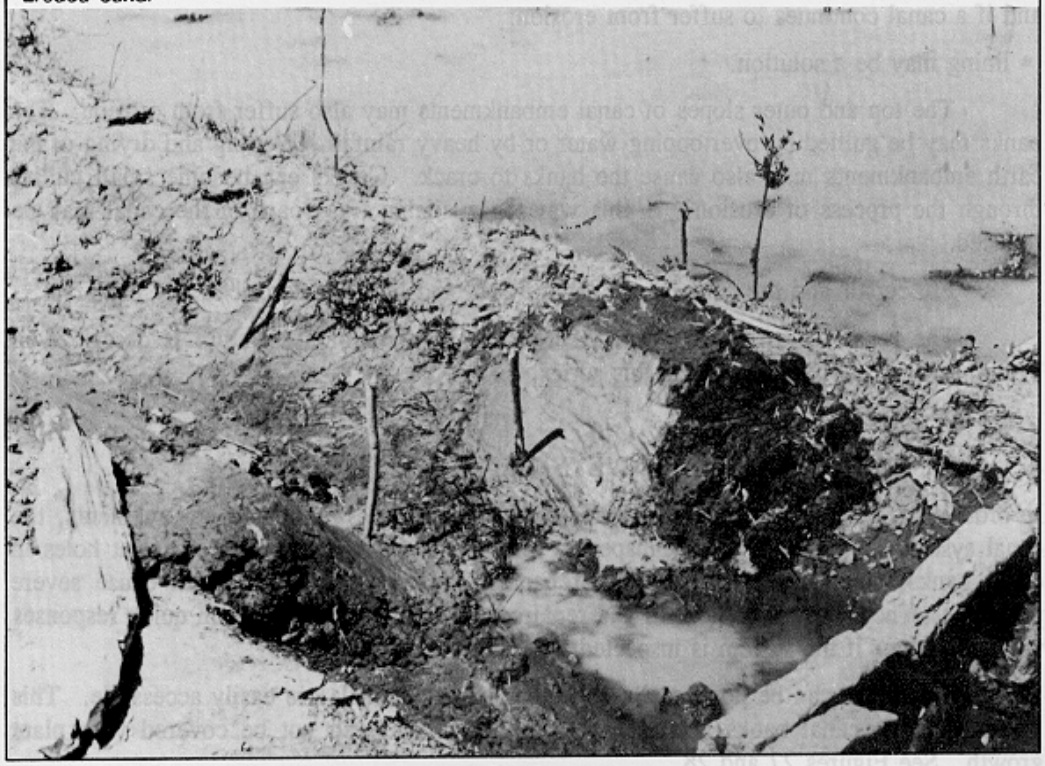


FIGURE 26
Eroded canal



Another problem is that the eroded soil will be deposited , known as siltation , in structures downstream of the eroded canal section. This may cause a malfunctioning of the structures. Eroded soil could also be deposited in canal sections, thus reducing the capacity and causing the flow to overtop the bank.

Canals that are constructed with soil that contains a high content of sand are very susceptible to erosion. To avoid erosion of such a canal, the flow velocity must be very low, and the side slopes must be flat. In this respect limits are set on the flow velocity and the side slope, and these are given in Table 2.

TABLE 2
Limiting side slopes and flow velocities for canals

Construction material	Limiting side slope	Limiting flow velocity (m/s)
Sand	1:3 (1/3)	0.4
Sandy loam	1:2 (1/2)	0.6
Clay loam	1:1.5 (2/3)	0.8
Clay	1:1 (1)	1.2
Bricks	1.5:1 (1.5) or vertical	1.5
Concrete	1.5:1 (1.5) or vertical	2.0

When the velocity in a canal exceeds the limiting flow velocity, unacceptable erosion of the canal is to be expected, and, when the side slopes of a canal are steeper than the limiting side slopes, the canal banks may collapse.

These limiting values depend on the material which has been used for constructing the canal. The flow velocity in a canal made with a clay soil can be higher than the flow velocity in a canal made from sandy material. The banks of a clay canal can also be made steeper than the banks of a sandy canal.

Erosion by water can be prevented by:

- reducing the flow velocity, and
- making the inner canal banks more stable,

and if a canal continues to suffer from erosion:

- lining may be a solution.

The top and outer slopes of canal embankments may also suffer from erosion. The banks may be gullied by overtopping water or by heavy rainfall. Wetting and drying of the earth embankments may also cause the banks to crack. Cracks can become small gullies through the process of erosion. In this way the available free board of the canal may be reduced.

For repair and prevention, see Section 5.6, and lining is described in Chapter 6.

The repair of an eroded canal section downstream of a structure is described in Training Manual 8: *Structures*, in this series.

4.3 INSPECTING THE CANAL SYSTEM

In order to prevent major problems such as leakages and destruction of embankments, the canal system should be regularly inspected throughout the irrigation season. Rat holes in canal banks, small leakages, erosion of canals and cracks in linings can cause severe problems. They must to be noticed and repaired as soon as possible. Such quick responses will only occur if the system is inspected frequently.

Inspection can be done easily and quickly if the canals are easily accessible. This means that the canal banks should have good pathways, and not be covered with plant growth. See Figures 27 and 28.

Who inspects the canal system?

Small irrigation systems are usually operated and managed by the farmers themselves through their own irrigation committees. They can take care of daily inspections of the canal system while passing the canals on their way to and from the fields.

In larger schemes, inspection of the smaller tertiary canals can be done every day by the farmers using the canal. Inspection of the secondary and primary canals in these larger schemes needs to be systematically organized by the irrigation committee.

Whoever inspects a canal and finds a shortcoming in the system should inform the irrigation committee as quickly as possible. The irrigation committee should then take action for immediate repair.

FIGURE 27
Heavy plant growth makes inspection difficult

FIGURE 28
Clean canal embankments are conditional for rapid inspection