A GUIDE TO THE STABILISATION OF WATER COURSES BY PLANTING INDIGENOUS TREES

By R. P. D. TUDOR-OWEN [1] and J. WYATT [2]

[1] *South African Sugar Association Experiment Station, Mount Edgecombe*
[2] *Natal Parks Board, Pietermaritzburg*

Abstract

The cane producing areas of the South African sugar industry are situated mostly in the catchment areas of gently to steeply undulating land, from which run-off flows into the major rivers on the Natal seaboard. It has been said that the lack of adequate integrated conservation practices on these farms has caused soil erosion, leading to degradation of the rivers and estuaries. Recommendations are made for stabilising water courses and drainage lines by using indigenous grasses and trees, together with the desired management practices gained from the experiences of growers in the Siyaya catchment.

Introduction

Water catchments can be considered as the basic units into which the land is divided. It is upon these environmental units that all life depends. Even the ecological requirements of the oceans are dependent on the condition of catchments and their estuaries. A healthy and stable catchment is therefore essential for a healthy coastline and marine zone. (Wyatt, 1990).

A catchment is made up of a number of sub-catchments which rise in the upland areas where water run-off concentrates into small streams, such as those which occur in the Drakensberg and Natal Midlands. As the streams converge, the flow volume of water increases until they give rise to our major rivers such as the Tugela and Umgeni. The stability of the catchment as a whole depends largely on its backbone, the riverine vegetation, which protects stream banks and adjacent slopes from heavy rains and rain damage, and reduces the loss of valuable topsoil.

Special features within the catchment such as sponges and marshes hold water and permit a slower, better controlled release of water to the system by reducing the intensity and frequency of flash floods, and by prolonging stream flow during droughts. Swamp forests along the streams and rivers provide 'plugs' or traps for silt in the form of root weirs which reduce the velocity of the water, thereby improving water quality.

Soil which is lost from arable land has often been cited as the main cause of degradation of rivers and estuaries. (Alexander, 1978). However, hydrologists have shown that changes to the morphology of the river channel itself and to the adjacent flood plain, due to the denudation of vegetation, are the major cause of sedimentation of river estuaries.

A river channel should be narrow and deep so that deposited sediments can be flushed out periodically by heavy rains. Vegetation physically protects the stream bank, but also promotes deposition of sediment along the channel. Constriction of the channel causes an increase in water velocity which in turn accelerates the removal of sediment from the stream bed, to the point where an equilibrium situation is reached where the river channel is narrower and deeper than it would be had the banks been unprotected. Removal of stream bank vegetation leads to erosion of the verges, which creates a wider channel. For the same volume of water, velocity will be decreased and greater deposition of silt will reduce the depth of the channel. A new equilibrium is reached where a wide, shallow channel is formed which is susceptible to the extremes of flooding and drought, and which cannot protect the valuable estuarine ecosystem.

A complex of wetlands, marshes, sponges and swamp forests with protected stream banks provides a stable and highly functional ecosystem for the whole catchment. Tampering with the system by removing or destroying vital components such as grass or trees, draining or damming wetlands, and crop encroachment of stream banks can rapidly cause the

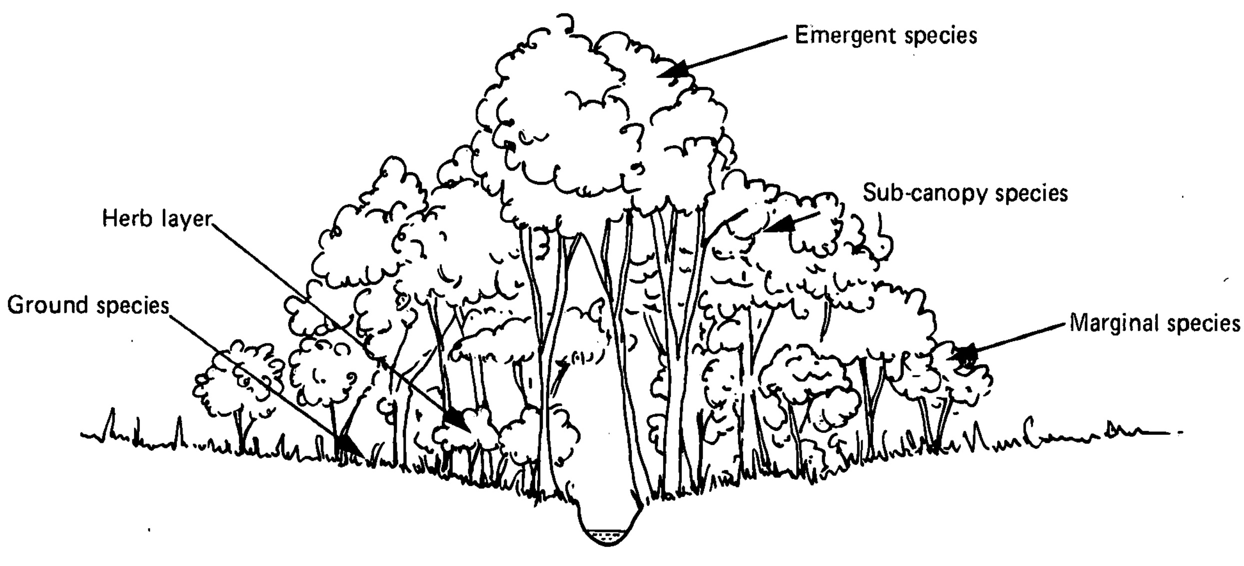

FIGURE 1 Typical canopy composition of stream bank vegetation.

collapse of the system and relegate it to a large unstable drain which merely serves to dispose of water and topsoil into the ocean. Ultimately, the system will become devoid of life.

Although the stabilisation of stream banks by judicious selection and placement of trees is discussed it is emphasized that a few trees cannot, on their own, support the catchment system and ensure its success. Trees are nevertheless a fundamental and indispensable component in a complex system of factors, each playing a vital role.

Of particular importance in the agricultural context is the need for sound and planned management practices within the catchment. Correct layout of conservation structures within fields, reduced tillage operations, strip cropping and trash mulching all are important in maintaining a stable ecosystem and ensuring the protection of our natural resources.

Method

Stream bank vegetation

Stream bank vegetation consists of various categories of trees as shown in Figure 1.

The various categories of trees comprise the following:

- Emergent species consisting of tall canopy trees such as *Bridelia micrantha, Syzygium cordatum* (Umdoni), *Voacanga thouarsii, Rauvolfia caffra* (Quinine tree), *Macaranga capensis, Ficus natalensis* (Fig) and the Raffia palm.
- Sub-canopy species which are smaller and grow under the canopy.
- Herb layer species which grow to about 1,5 m.
- Ground layer species consisting of grasses, broadleaf herbaceous plants, and ferns.
- Marginal species consisting of small trees and shrubs which grow at the edge of the canopy, e.g. *Psychotria capensis.*

The canopy of emergent and marginal species forms a dome, the leaves of which not only act as energy fixers and breathers, but also protect the micro-climate within the dome from excessive sunlight and wind. A stable situation thus exists. Damage to or removal of part of the canopy will create instability and affect the remaining components. For example, removal of the marginal species to plant crops will also allow greater penetration of the canopy by wind. This will cause a drying effect and increase the fluctuations in temperature. Such disruption of stability imposes stress on the rest of the canopy.

The presence of a marsh or swamp with sedges and reeds adjacent to a stream bank contributes to its stability. Removal or drainage of these areas will impact on the stability of the whole riverine community. It should be further noted that planting trees in a stable wetland, when sedges and reeds are growing satisfactorily, may have a seriously destabilising influence.

Rehabilitation of degraded stream banks

The most important rule in river stabilisation is to guide and contain the river in its original channel wherever possible. River canalization is definitely not a solution in most cases. Straight, regular channels seldom occur in nature, and a river can only be forced to take this unnatural path by the establishment of expensive retaining structures, while the self- cleansing function of the river is lost.

Table 1

Indigenous trees suitable for afforestation of watercourses

	Botanical name	Common name	Zulu name	Area	Frost resistance
Category 1 Front-line trees with vigorous rooting characteristics	*Bridelia micrantha*	Mitzeerie	umHlahlamakhwaba	C	
	Phoenix reclinata	Wild date palm	iSundu	CM	X
	Raphia australis	Kosi palm	umVuma	C	
	Rauvolfia caffra	Quinine tree	umHlambamaze	C	
	Voacange thouarsii	Wild frangipani	umKhadlu	C	
	Syzygium cordatum	Umdoni, Water berry	umDoni	CM	X
	Macaranga capensis	Wild poplar	iPhumela	C	
	Ficus natalensis	Natal fig	umThombe	CM	
	Ficus sur	Cape fig	umKhiwane	CM	
	Leucosidea sericea	Ouhout	Inishishi	MB	XXX
	Harpephyllym caffrum	Wild plum	umGwenya	C	X
	Acacia robusta	Splendid thorn	umNgamanzi	CM	X
	Rhus chirindensis	Bostaaibos	IKhathabane	CM	XX
	Combretum erythrophyllum	River bush-willow	umDondwe	M	XXX
	Barringtonia racemosa	Powder-puff tree		C	
Category 2 Pioneer or pre-cursor trees	*Aracia karroo*	Sweet thorn	uMunga	CMB	XXX
	Trema orientalis	Pigeonwood	uBhatini	CM	
	Albizia adianthifolia	Flat crown	umGadenkalou	C	X
	Antidesma venosum	Tassel berry	isiBangamlotha	C	X
	Croton sylvaticus	Forest croton	umHlalanyoni	CM	X
	Buddleia salvilfolia	Sagewood	iLoshan	MB	XXX
	Celtis africana	White stinkwood	umVumvu	CMB	XX
Category 3 Trees with commercial and medicinal value	*Podocarpus latifolius*	Real yellowwood	umSonti	MB	XXX
	Podocarpus falcatus	Outeniqua yellowwood	umSonti	MB	XXX
	Millettia grandis	Umzimbeet	umSimbithi	C	X
	Ocotea bullata	Stinkwood	umNukane	M	
	Warburgia salutaris	Pepper-bark tree	isiBhaha	C	
	Bersama lucens	Glossy bersama	isiNdiyaza	C	
	Curtisia dentata	Assegai	IsiNama	M	X

Area codes: C = Coastal, M = Midlands, B = Berg or highlands
Frost resistance: X = mildly tolerant, XX = fairly tolerant, XXX = highly tolerant, unmarked species = no resistance

Although certain principles apply when trees are planted along a watercourse, there will always be a number of ways to achieve the desired result. There are no specific rules for numbers, or particular species, but an understanding of the diverse growth habits and rooting patterns of trees will minimise the risk of making mistakes. The position of the stream or river in the catchment will also influence the rehabilitation technique.

Before commencing a programme of stabilising stream banks an assessment should be made of the relative need for trees, grasses, sedges, or other indigenous vegetation. Random planting of trees down watercourses will not necessarily achieve anything except the easing of a conscience. Any perennial or seasonal watercourse which is subject to erosion should be considered for tree planting. However, artificial waterways are often best stabilised by shaping, followed by the planting of creeping grasses. Marshes, vleis and very wet waterways are best planted with reeds and sedges.

Tree planting in riparian zones should not be formal or in straight lines, but scattered with about 3 m between trees, in order to establish a closed canopy and an extensive root system as quickly as possible, and to allow for some tree mortality.

The first step in rehabilitating a watercourse or riparian zone is to remove alien invader plants. Invader plants will not be discussed in this paper, but both the Natal Parks Board and the SA Sugar Association Experiment Station can advise on the subject.

Secondly, by minimum tillage methods, the crop should be moved to between 3 to 10 m from the shoulder of the bank, depending on the size and capacity of the stream in peak flow.

Preparation of planting holes, planting media, and propagation of trees is discussed in Information Sheet No. 24, produced by the SASA Experiment Station.

Choice of tree species

In Table 1 are listed some common tree species which are suitable for the stabilisation of water courses. (Wyatt, 1990).

Placement of trees

Figure 2 shows an example of a revegetation plan for the eroded bank of a perennial stream.

The left bank of the stream is nearly vertical and very unstable. The first or front line of trees should be planted well back (position A) from the shoulder which in time will assume a more stable profile as the unstable soil sloughs off, as indicated by the dotted line.

Where the shoulder is less steep and more stable on the other bank, trees may be planted close to the stream, as in position B. A second 'line' of precursor or pioneer species should be established behind the front-line trees in position C. Pioneer species grow rapidly and serve to 'assist' the front line trees by providing shade and some protection from wind. They also fruit early and attract fruit-eating birds, which will introduce seeds of these and other local tree species. Front-line water tolerant species are located at or adjacent to the water.

Figure 3 shows the same watercourse in plan view. The location of the trees relative to one another is clear.

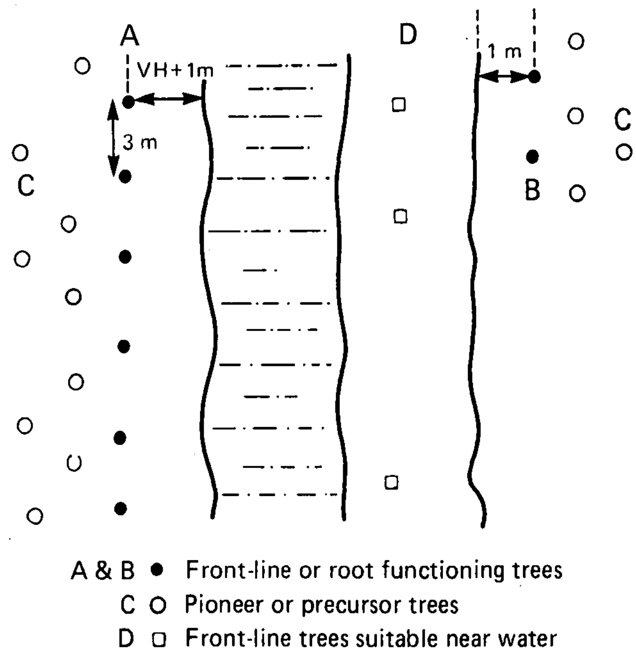

FIGURE 3 Plan view of perennial stream.

Tree species favoured for the front-line position are *Ficus natalensis* (Natal fig), *Ficus sur* (Cape fig), *Bridelia micrantha, Syzygium cordatum* (umDoni), *Phoenix reclinata* (iSundu) and *Acacia robusta* (Table 1). These trees have particularly vigorous root systems, well suited to stabilising banks rapidly. Where water tables are higher, as in position D in Figures 1 and 2, *Voacanga thouarsii* (Wild frangipani) or *Rauvolfia caffra* (Quinine tree) are ideal. Suitable pioneer species are *Acacia karroo, Trema orientalis* (Pigeonwood), *Albizia adianthifolia* (Flat crown) and *Celtis africana.*

Trees with commercial or ornamental value can be placed away from bank edges along with the pioneer species or behind them. Species such as *Podocarpus* spp (Yellowwood) and *Millettia grandis* (umSimbithi) are appropriate.

Trees with medicinal value to the traditional herbalist, such as *Ocotea bullata, Warburgia salutaris* etc, which are in demand, can be planted in a similar position.

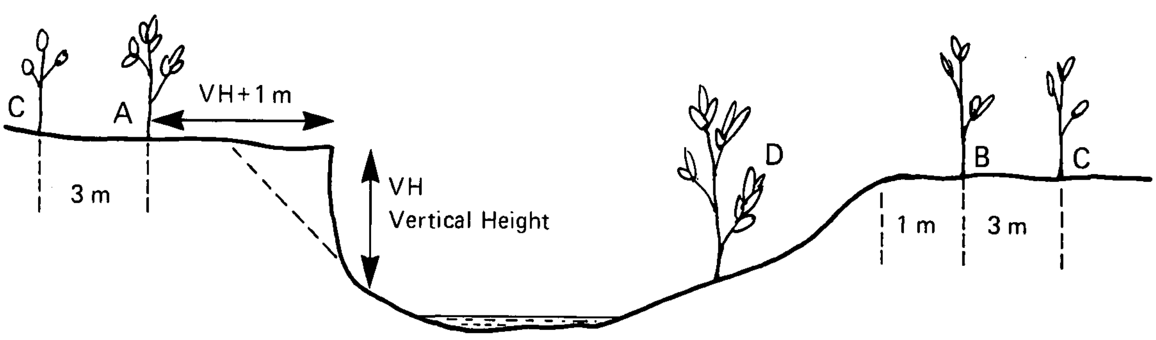

FIGURE 2 Cross-section of eroded bank of perennial stream.

Planting trees in straight lines with regular spacing is not recommended. It looks unnatural and does not form an efficient barrier against flood waters and deposition of silt. It is preferable to place trees in groups where weak points occur along the water course or stream. Suitable trees grouped around these points are far more effective.

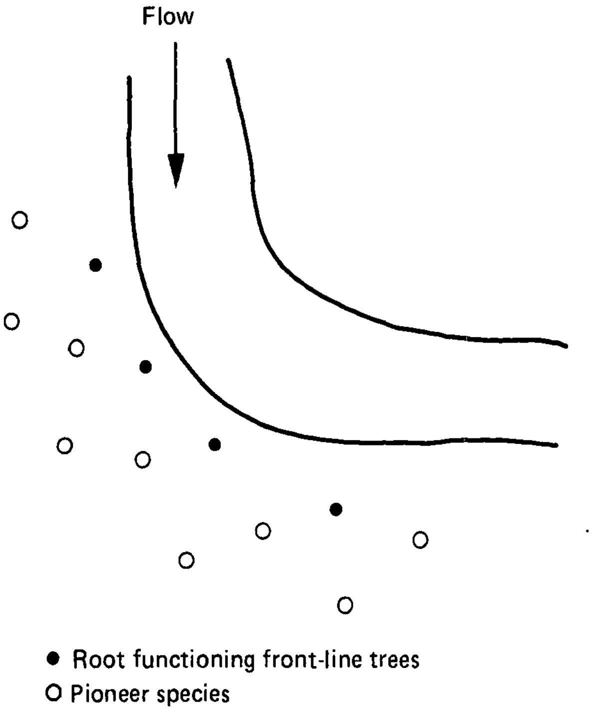

FIGURE 4 Placement of trees on bend in water course.

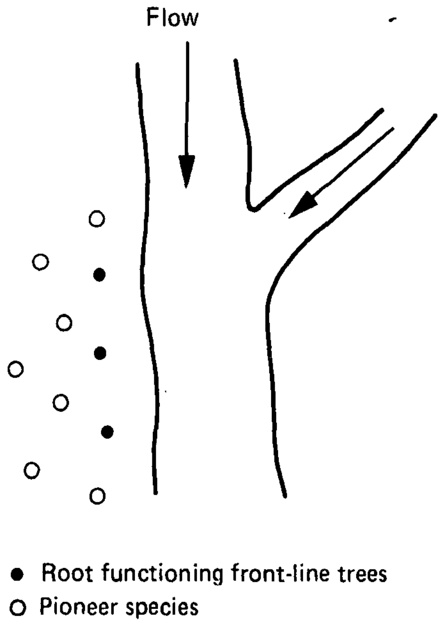

FIGURE 5 Placement of trees at confluence pressure point.

Pressure points usually occur on bends where the water flow is forced to change direction, where two streams converge, or where flow is constricted, as may occur in culverts or pipes under roads. Front-line trees most suited to these situations are *Phoenix reclinata* and *Raphia australis*, backed by *Bridelia micrantha* as the pioneer species. Figures 4, 5 and 6 illustrate how the trees should be planted in these situations.

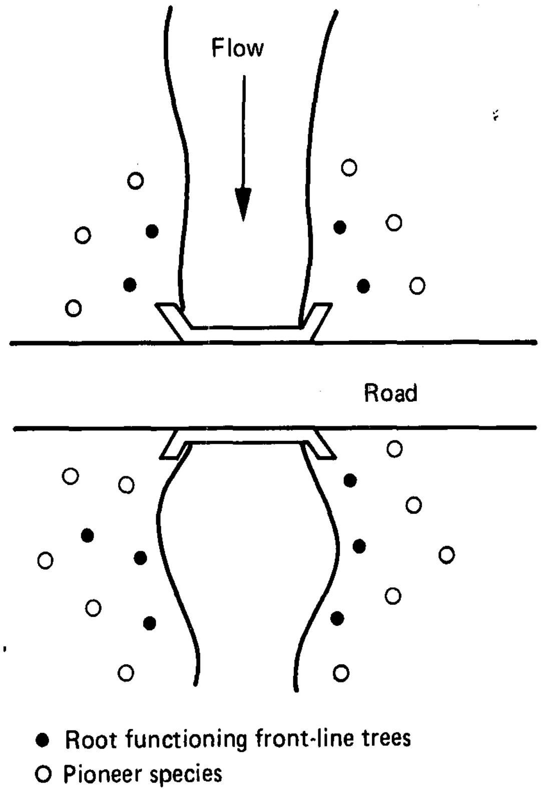

FIGURE 6 Placement of trees at constriction pressure point.

Conclusions

The above guidelines are simple and practical, and should be regarded as general recommendations. With experience and greater knowledge of the specific growth characteristics of different tree species, successful revegetation and stabilisation will become a routine task, and an integral part of the whole farm management programme. Already there are a number of cane farms in Natal where these practices are achieving the desired effects with stability and balance restored to the ecosystems.

REFERENCES

Alexander, WJR (1978). The effect of river management practices on the sedimentation of estuaries. Symposium: The relationship between agriculture and environment conservation in Natal and KwaZulu. Durban.

Wyatt, J (1990). Indigenous afforestation of degraded watercourses. Technical guidelines for Farmers. Bulletin No. 24.