Placing trees for maximum salinity control

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There is some debate in determining the best place in the landscape to plant trees for maximum effect on the watertable. For many years it was assumed that trees should be planted where the water was coming to the surface (discharge areas). Although such planting can be a useful discharge management option, it has a negligible effect on the long-term water balance of a site, and more often than not, the trees eventually die as the watertable continues to rise or salt concentrates in the roots.

Current research tells us that the most effective way to control rising watertables is to stop water entering the watertable in the first place (recharge management). However, as most of a catchment can be considered a recharge area and the whole catchment cannot be planted with trees, the best areas for planting must be found. This Farmnote describes a hypothetical catchment of 100 hectares, and the effects that different tree placements may have on the overall water balance.

A simple water balance example

It is often very difficult to understand the volume of water stored or moving in a groundwater system that causes saline areas. It is even more difficult to understand the impact of any particular tree planting strategy on this groundwater. A series of simple visualisations and the impacts of three tree-planting designs on groundwater flow should make this simpler.

This information is suitable for local groundwater systems, especially those in the woolbelt and wheatbelt, but is not suited to sites planted on intermediate and regional flow systems, such as occur on the Perth and Bremer basins.

Case 1 – water balance of the hypothetical catchment

The hypothetical catchment (see Figure 1) receives an average of 50 millimetres of recharge, equivalent to a total of 50,000 cubic metres of water entering the groundwater system annually. Recharge is not even across the catchment. Twenty hectares of high recharge soil (e.g. deep sand or gravel) contribute 60 per cent of the total (150 mm), with 70 hectares of duplex soil contributing 40 per cent (29 mm) annually. The remaining 10 hectare salt or waterlogged area at the bottom of the catchment discharges 25,000 cubic metres annually, or half the recharge. In the example, there is an excess of 25,000 cubic metres which means that the discharge area can be expected to become larger, potentially doubling if insufficient capacity exists for increased discharge rates (20 hectares or 20 per cent of the catchment).

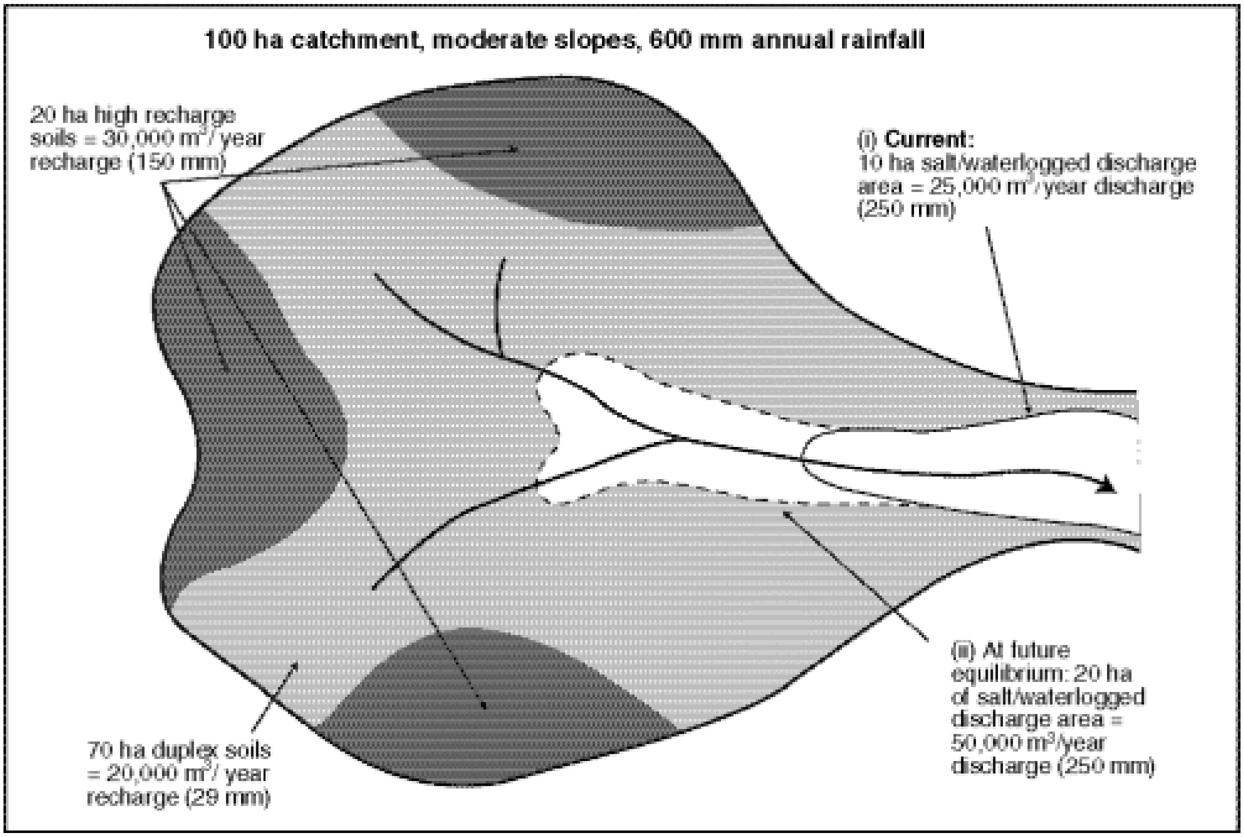

Figure 1. Hypothetical catchment with assumed current hydrological conditions

Case 2 – 10 hectare area of trees (10 per cent of catchment) is planted in a belt above the current saline area to intercept the groundwater

In *ideal* conditions, trees can be expected to use up to 450 mm of water from the watertable in addition to the annual rainfall component. For this to occur, the groundwater would need to be relatively fresh (salinity less than 1,000 mS/m or one sixth as salty as seawater), readily accessible to the roots and in a relatively thin aquifer, at a maximum depth of 5 metres. In this case, the planting could use 45,000 cubic metres of groundwater (90 per cent of the recharge), nearly balancing the total recharge in the catchment, and the discharge area would be expected to contract to 2 hectares.

However in normal medium rainfall zone conditions, groundwater salinity is greater than 2,000 mS/m and the aquifer is 10 to 20 metres thick. Trees are expected to use only annual rainfall and almost no groundwater. They would then only prevent 30 mm of recharge beneath them, reducing groundwater flow by 3,000 cubic metres and the discharge area would continue to *expand* through the planted area to nearly 19 hectares.

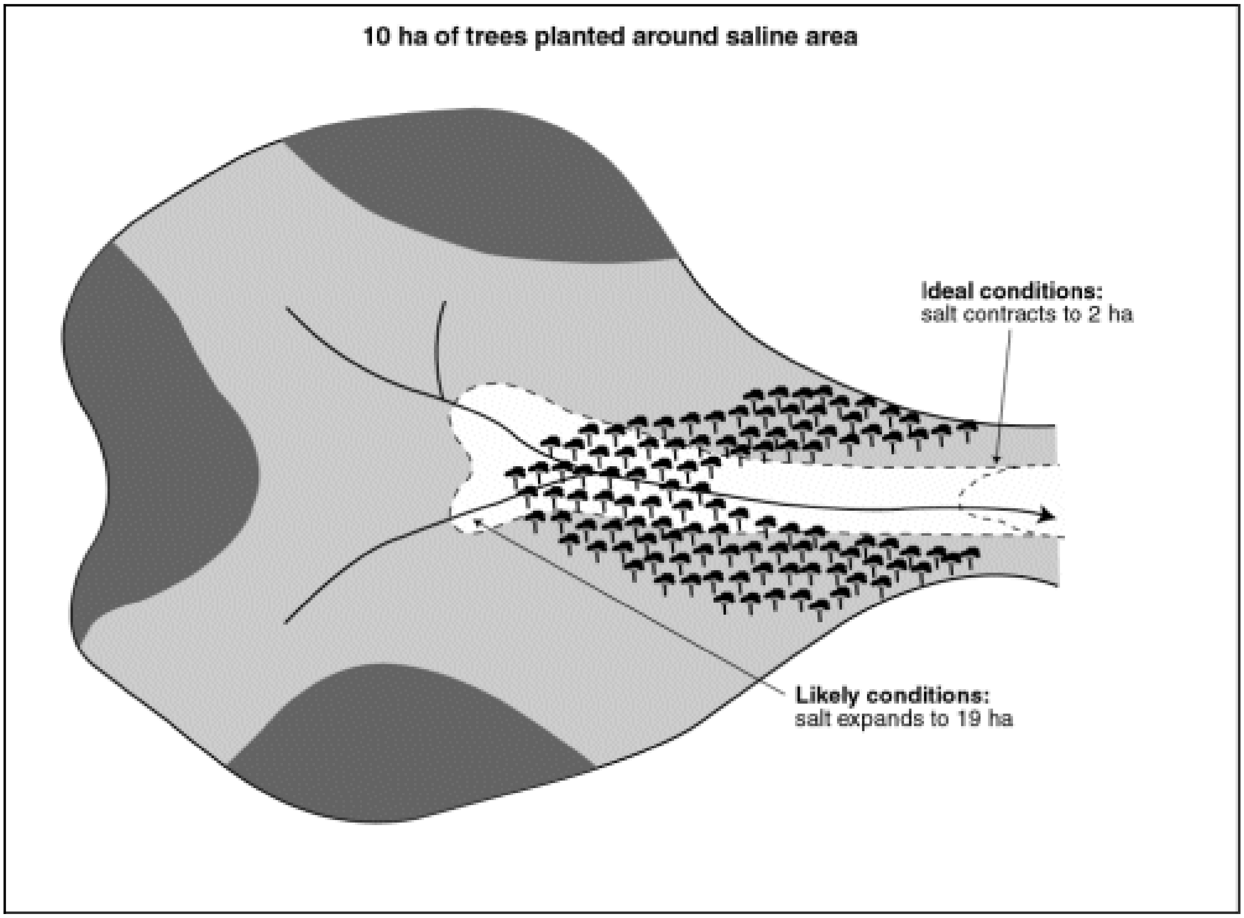

Figure 2. Trees are planted in a belt above the current saline area

Case 3 – Three-row alleys planted at 50 metre intervals across the catchment

It is reasonable to assume that trees would influence (almost eliminate) recharge for 10 metres either side of the belts. Assuming this, the configuration in Figure 3 (about 20 hectares of trees in total) would remove nearly 60 per cent of recharge or 30,000 cubic metres, leaving 20,000 cubic metres to be discharged. This is less than current discharge and the saline area would be expected to *contract* by 2 hectares.

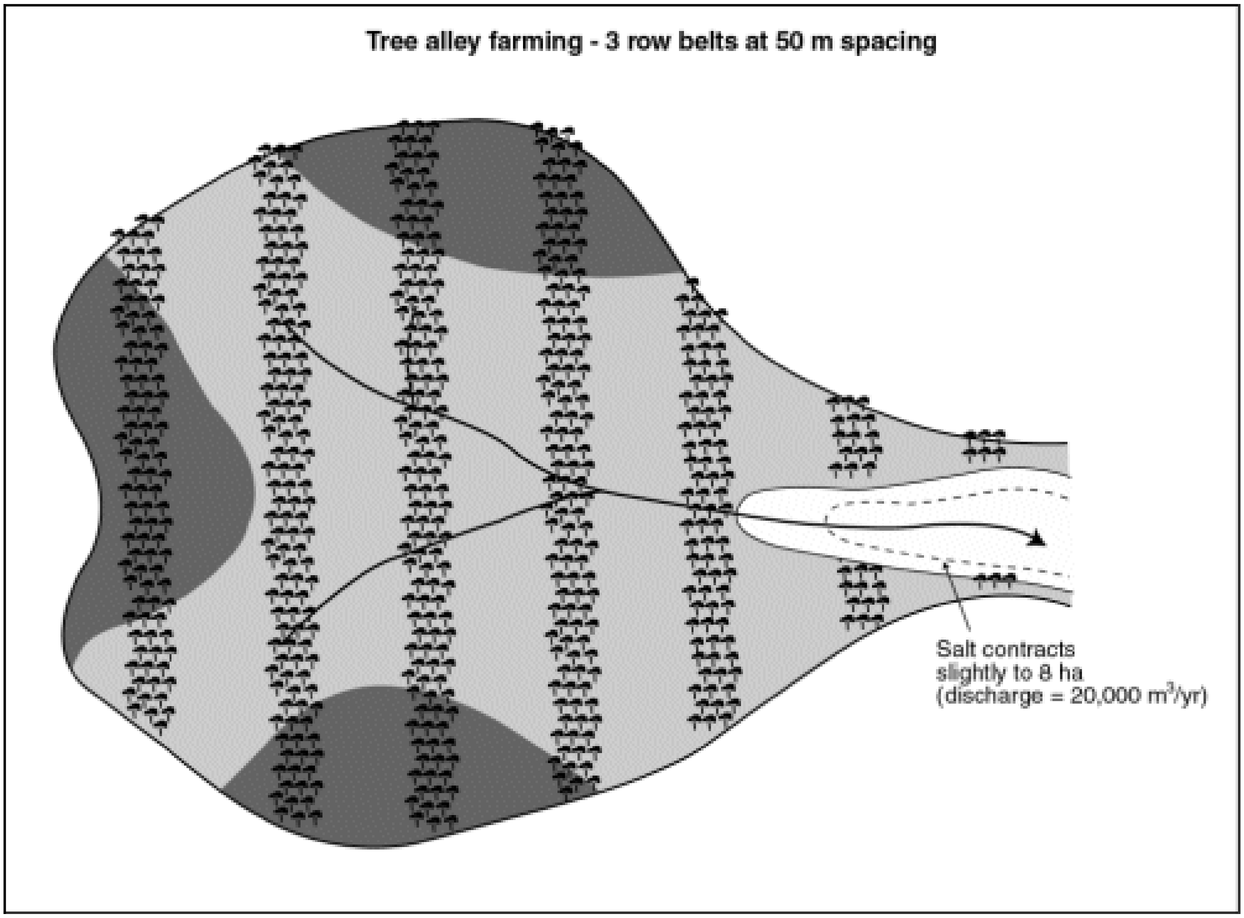

Figure 3. Three-row alleys planted at 50 metre intervals across the catchment

Case 4 – Six-row alleys planted at 100 metre intervals across the catchment

A six-row alley system (Figure 4) has a similar area of trees planted as Case 3, but because the trees are spaced more widely, they influence less of the catchment (40 per cent) and only remove 20,000 cubic metres of recharge. About 30,000 cubic metres of recharge remain, which is 5,000 cubic metres more than current levels. The area of discharge is therefore expected to *expand* by 2 hectares.

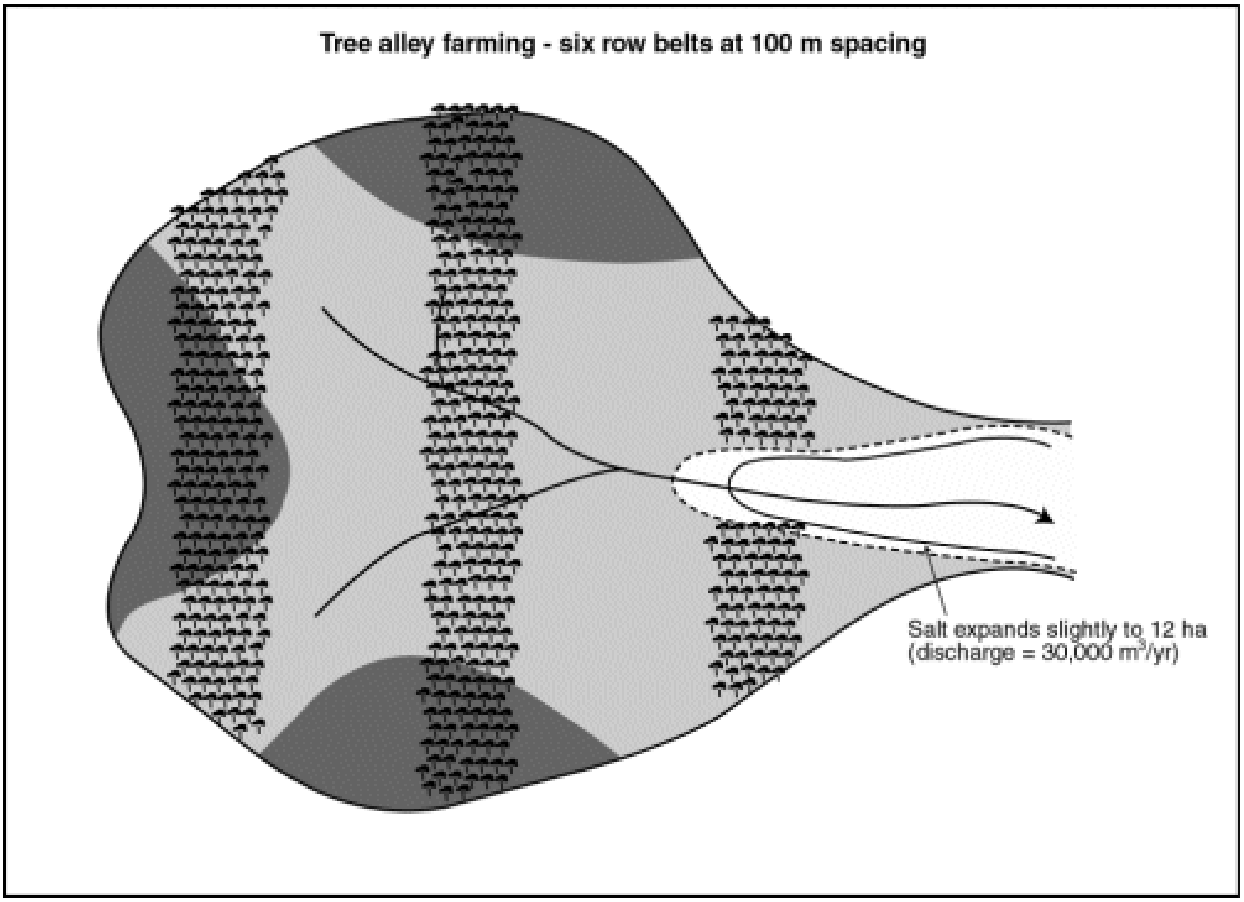

Figure 4. Six-row alleys planted at 100-metre intervals

Case 5 – All high recharge soils planted to trees

The 20-hectares of high recharge soils are planted with trees, effectively removing all recharge under these areas (Figure 5). Thus, 30,000 cubic metres per year will be removed from the groundwater system, leaving 20,000 cubic metres, or 5,000 cubic metres less than currently discharging from the 10 hectares of saline or waterlogged land. The area of saline land can be expected to *contract* by 2 hectares.

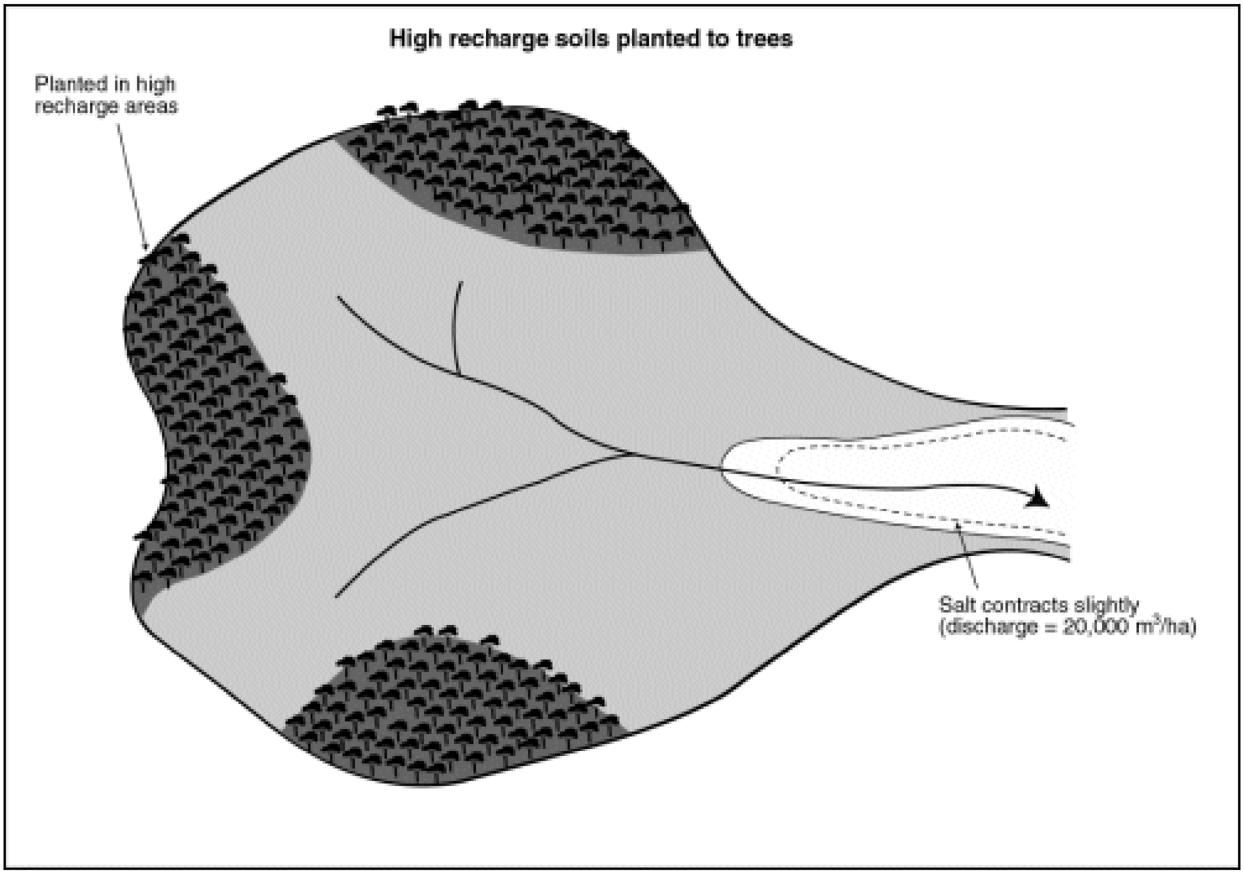

Figure 5. All high recharge soils planted to trees

Case 6 – The catchment has minor geological complexity

A dolerite dyke (or zone of shallow bedrock) causes restriction to groundwater flow (Figure 6). The pattern of discharge will change so that about half of the discharge area is located above the dyke in the mid-slope. The area targeted for trees will change because the area of high recharge soils at ‘A’ will have almost no impact on the groundwater accumulating above the dyke. Similarly, areas ‘B’ and ‘C’ have little impact on the groundwater discharging at the bottom of the catchment.

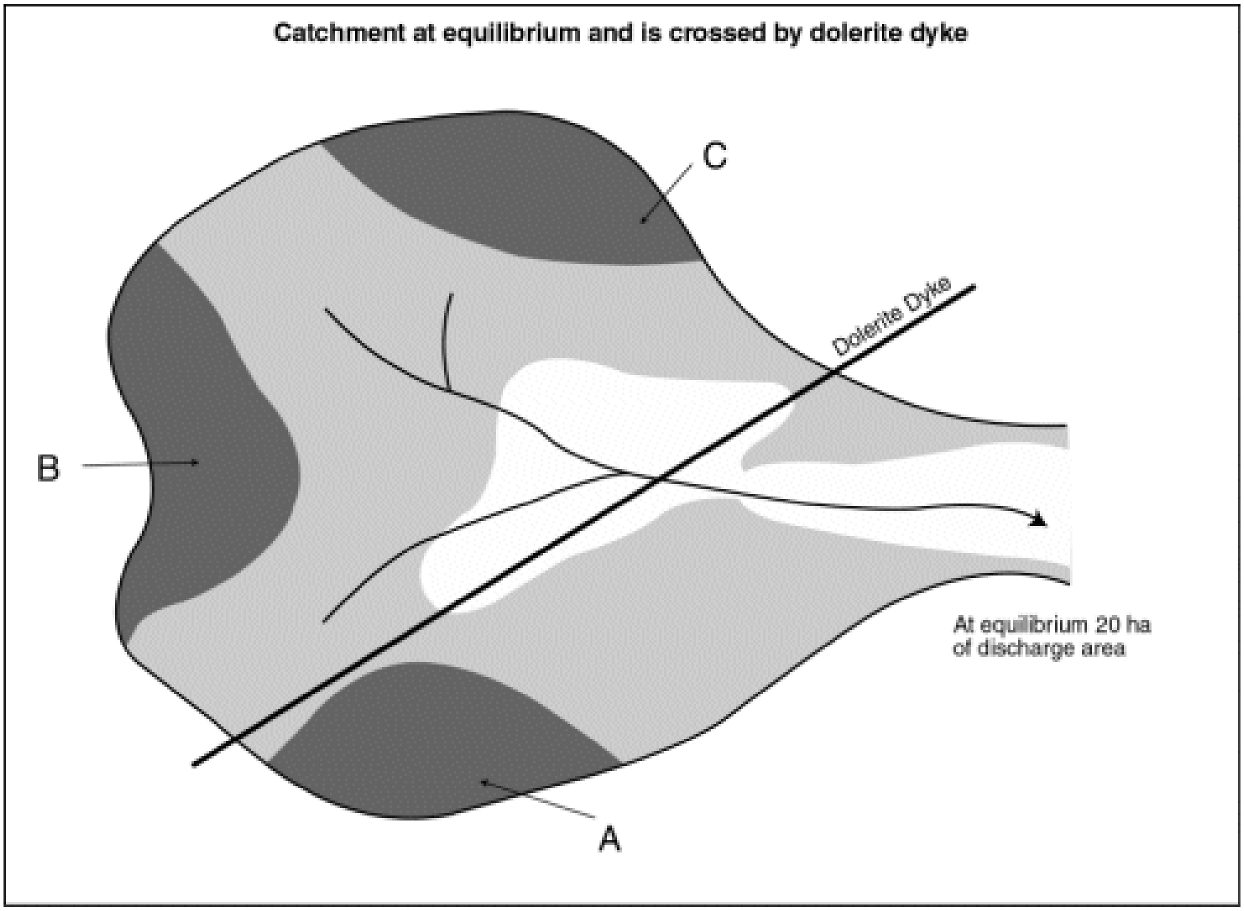

Figure 6. The catchment has minor geological complexity

Lessons to be learnt

Catchments usually contain large volumes of groundwater. In the example, 50,000 cubic metres of recharge is added to the groundwater system each year from a 100-hectare catchment. At equilibrium the catchment must discharge an equivalent amount of water. This usually shows as an area of saline seepage (10 per cent of the catchment in the example used).

Conditions must be ideal if trees are to use water after it has entered the watertable and before it discharges at the saline area. The groundwater needs to be fresh, shallow (less than 5 metres from the surface), and the soil and aquifer permeable. Even with ideal conditions, a large area of trees is required (10 per cent in the example). Experience has shown that such ideal conditions are unlikely for most catchments in the medium rainfall zone and therefore this approach is likely to fail.

If trees are planted to intercept recharge on catchment slopes before it enters the groundwater system, they need to be either very well distributed or target high recharge areas. Planting blocks of trees on deep sand and gravel areas that have high recharge rates can be more effective in reducing salinity. In the example, planting 20 per cent of the catchment removed 60 per cent of the total recharge to the groundwater. However, it also demonstrated that introducing even a low level of geological complexity can radically change the distribution of salinity and the areas that should be targeted for tree-planting.

For recharge management, a significant area of the catchment (greater than 20 per cent in this example) must be planted to begin to significantly reduce salinity (less than 10 per cent in this case). Therefore in simple economic terms it is important that the trees have an economic value similar to, or more than, the agricultural activity that they are replacing.

Very simple water balance calculations such as those used here can be very useful in analysing the likely impacts of revegetation on salinity. Computer models such as AgET and FLOWTUBE are available to assist landholders in making informed decisions about likely impacts of different tree plantings.

Recommendations

1. Know the hydrology of the site for best tree placement.
2. Determine planting objectives.
3. Select economic species for possible future outcome.
4. Select suitable soils, match species to site conditions.
5. Assess likely impacts before investing.
6. Monitor performance and impact.
7. Seek advice from Department of Agriculture and CALM farm forestry experts.

Trees are only one means of salinity management. Other perennial-based options (e.g. lucerne) are being developed and new species screened. Engineering systems such as surface drainage, deep drainage and groundwater pumping can complement the use of trees and other perennials; and land which remains saline can be targeted for saltland management systems.

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