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Defusing the salt time bomb

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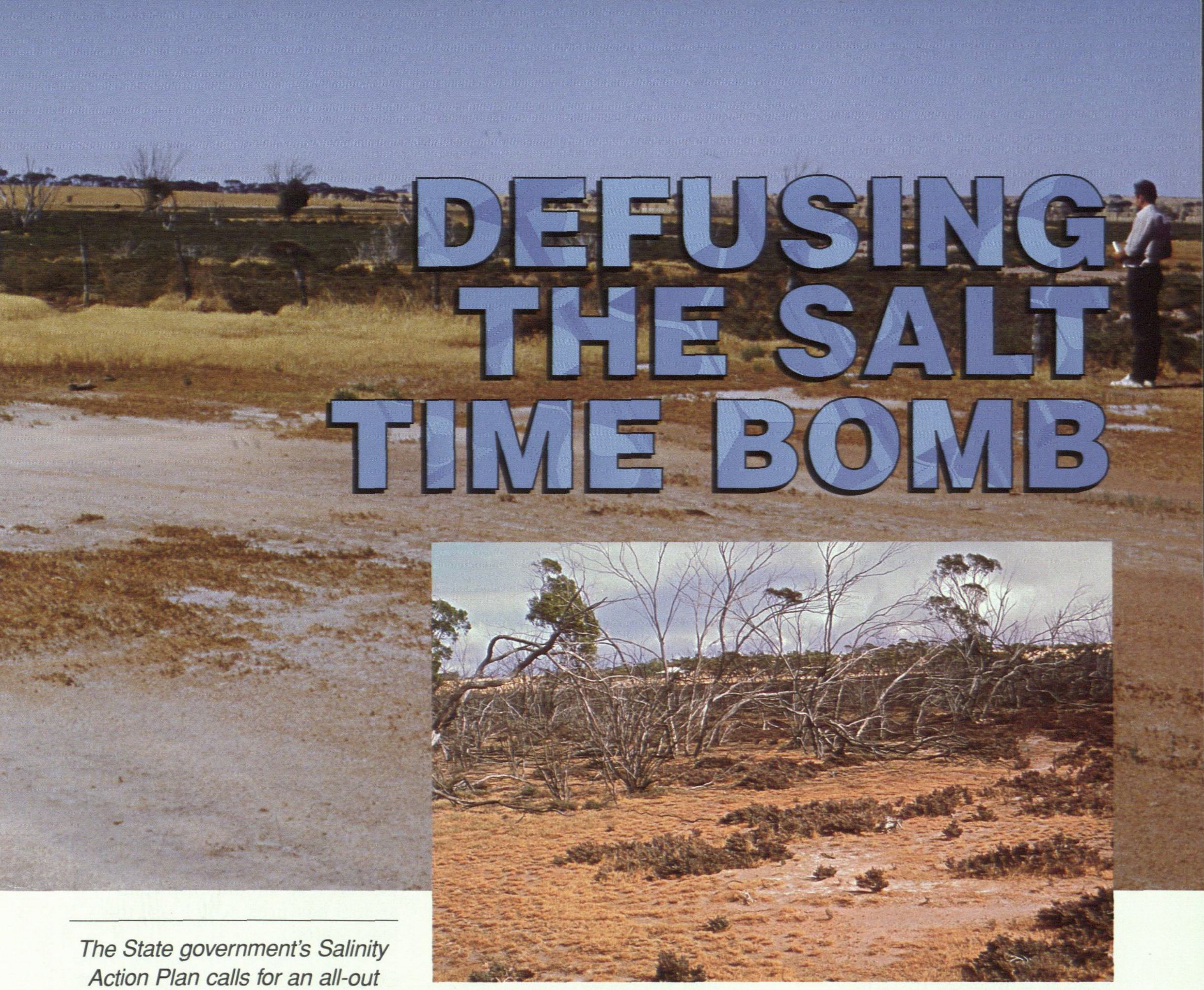


DEFUSING THE SALT TIME BOMB

Uncleared valley now totally affected by salt

*The State government's Salinity Action Plan calls for an all-out offensive on the salt time bomb. **David Berry** spoke with some of the key research personnel in the program and he reviews the strategies and the research which will give us total water use.*

That there was a salt time bomb ticking away beneath Western Australia's agricultural land should not have surprised us.

In 1864, Henry Lefroy, Superintendent of Convicts on a farm east of York, commented: "To the very important question of good water, it being evident that flocks must depend on well water, I record my opinion that subsoils must contain the salts bought into them annually for countless ages, as salts must be left in the soil by evaporation".

Nor can we claim that warnings were never given of the risk of the bomb going off. In 1917, J. W. Paterson, Professor of Agriculture at the University of Western Australia, presented soil samples and a report to the Royal Commission on Mallee Belt and Esperance Lands. Paterson claimed that probably one third of the area considered for development was too saline for profitable farming. The response he got was: "... the Commission having given the question close consideration, strongly urges that scientific prejudice against our mallee lands be not permitted to stand in the way of their being opened up for agricultural purposes".

And so the clearing continued. Today about 18 million hectares of Western Australia has been cleared for agriculture, 1.8 million hectares is salt affected. By the years 2010/20, the area of salt affected land is forecast to rise to 17 per cent, and could go as high as 32 per cent (6 million hectares) before a new salt balance is reached.

It is estimated the capital value of the land lost so far, including the cost of lost production opportunities, is in the order of $1445 million.

Full recognition of the magnitude of the problem came last November when the State Government launched its Salinity Action Plan, which acknowledges salinity as "Western Australia's biggest and most dangerous environmental problem".

"It will be a long and costly war, but it must be fought. And it has to be won." Three billion dollars needs to be spent over the next 30 years, and 3 million hectares of appropriate trees and shrubs will have to be planted, to make a "significant" impact on the problem, the Government says.

The plan marshals the joint resources of Agriculture Western Australia, Department of

Conservation and Land Management (CALM), Department of Environmental Protection (DEP), Water and Rivers Commission and landholders for an all-out offensive on salt. Within Government a Cabinet Committee headed by the Premier and Deputy Premier is spearheading the attack.

The Salinity Action Plan concedes the impossibility of eliminating salinity in the foreseeable future. Instead it displays extreme determination to dramatically reduce the impact of salinity, and outlines clear strategies for doing so.

Table 1. A comparison of water use in native vegetation and cleared agricultural land.

	Native vegetation	Cleared agricultural land
Rainfall	370 mm	370 mm
Run-off	0 mm	18 mm
Evapotranspiration (soil surface evaporation and leaf surface evaporation)	359 mm	319 mm
Interception loss (from wet leaves)	11 mm	7 mm
Rainfall to groundwater	0 mm	26 mm

In the beginning

The salinity battle plan leans heavily on the results of a far-reaching study conducted in the Lake Grace–Newdegate area over 11 years up to 1982. The study provides a unique 'before and after' baseline for understanding and measuring the salting of land throughout the State.

The subject of the study was a 265 hectare patch of virgin mallee scrubland with an area of cleared farmland alongside. Under the stewardship of the then research officer and now Manager of Agriculture Western Australia's Natural Resources Management Services, Bob Nulsen, a comparison of the two areas was conducted.

The area was drilled with holes, some as deep as bedrock – up to 47 metres deep – to take a variety of water monitoring devices. Table 1 shows how every drop of rain was accounted for.

In an average year, rainfall on the virgin bushland contributed zero to the rising salinity problem. But on the cleared agricultural land, 26 millimetres of the 376 millimetres rainfall found its way to the groundwater, from which there was no escape.

Today, Bob cautions sceptics who might say that 26 millimetres flowing to the watertable out of a rainfall total of 370 millimetres is a very small proportion. "Don't forget that it can't get away as fast as it arrives. Also, because the soil is mostly solids, 26 millimetres of rainfall can raise the level of the watertable by between 200 and 500 millimetres."

Hillside seep behind a dolerite dyke. (running across the picture)

Evapotranspiration

Evapotranspiration is researchers' jargon for the total of evaporation from the soil surface, plus the water used and transpired from the plants and trees.

Water use is highest from trees, and diminishes through perennial pastures, to annual crops and annual pastures, which use the least water.

Evapotranspiration of agricultural crops is commonly in the range of 250 to 500 millimetres a year, that is, less than 50 per cent of annual rainfall.

The principal thrust of the Salinity Action Plan is to increase evapotranspiration in order to contain the recharge of the watertable. The Plan's strategies include using annual and perennial plants (including trees), and engineering systems such as drainage and the collection and recycling of surface water.

Annual cropping

Steve Trevenen is Agriculture Western Australia's Cereal Products Program Manager and is encouraging wheatbelt farmers to start factoring total water use into their cropping rotations and variety selections.

He says an important point is that crop yield is not necessarily a good gauge of water use. "The length of the variety's growing period is a far

Salinisation of the broad valley flats in the wheatbelt has killed Salmon Gum (Eucalyptus salmonophloia) *woodlands which are not regenerating.*

better gauge – the longer it grows the more water it uses."

Steve urges farmers not to make hasty judgements when selecting rotations. "For example, a lupin:wheat:canola rotation might look a poorer prospect than a more traditional wheat:pasture rotation. But because of canola's high water use, perhaps only 10 per cent of the farm will need planting to trees, instead of, say, 15 per cent for the wheat:pasture option. In the long-term, an extra 5 per cent of the property would be released for cropping!"

Which crops?

David Hall, Research Officer – Plant Soil and Water Relationships at Agriculture Western Australia's Esperance office, is researching the water uptake of various crop species and the relationships of crops to trees. The work is funded by the Federal Grains Research Development Corporation.

He says the biggest challenge is finding rotations "robust" enough to keep the watertable below the root zone, not just for the crop years, but for the whole rotation.

"The main culprit is the annual pastures – they take time to develop which gives the watertable time to rise."

David says the criteria they're looking for with pastures is high leaf area, a deep root system and a long growing period, and perennials offer all three.

He says farmers are very interested in production and land care, but "...the marriage of the two is not yet complete with all farmers". A big problem is that short-term finances are worrying farmers at the moment, which reflects low wool and cattle prices and lingering uncertainty that good grain prices will hold.

Crop cultivars

Of all the conventional crops, none has a higher water use than canola. At Esperance, for example, canola cultivars used 13 to 33 millimetres more water than lupin and barley varieties.

Variations exist between varieties, whether canola or barley, mostly related to the length of the growing period and green leaf area. Franklin barley, for example, a longer season variety, increased water depletion in trials at Dalyup by as much as 20 millimetres compared with Stirling barley.

When asked for a State-wide view, David replies: "There is no evidence that annual crops or pastures, no matter how well they are managed, can by themselves reduce the rate at which watertables are rising. We need an integrated system of high water use perennials to compensate for the annuals."

An indication of the shortage of perennial vegetation, State-wide, is gained by looking at the Esperance and Ravensthorpe Shires, where 1.6 million hectares of the total 2.4 million hectares have been cleared. Less than 2 per cent of the farmland is sown to perennial pasture or commercial timber.

Perennial pastures

Lucerne is experiencing something of a revival because of its capacity for mopping up watertables. At Gairdner, transpiration from lucerne exceeded rainfall by 50 millimetres per year. It was head and shoulders above wheat in water use, attributed largely to its drying of the soil profile during the summer months.

Kikuyu also performs well. On deep sands at Gibson, kikuyu reduced water storage by between 50 and 100 millimetres, when compared with neighbouring annual pastures.

Fodder shrubs – tagasaste

Another crop enlisted by the Salinity Action Plan is the high protein legume, tagasaste.

In the West Midlands, the home of deep sand agriculture, tagasaste is successfully mimicking the water use of native vegetation. According to Tim Wiley from Agriculture Western Australia's Jurien Bay office, "It has been proven to lower watertables significantly and reduce salinity".

Groundwater pressures 3m above ground in a discharge site planted to blue gums. More planting in the recharge area is required to remove the pressure.

The Salinity Action Plan has set a short-term target of half a million hectares of tagasaste, of which up to 100,000 hectares is planted already as plantations, mostly in the West Midlands. There is potential for as much again using "alley farming", primarily as a commercial treatment for wind erosion, with seven metre-wide rows planted 50 to 60 metres apart, Tim says.

"On poor sand-based annual pastures, where subterranean clovers battled to grow, tagasaste is providing a five-fold increase in carrying capacity – from 1 to 2 DSE (dry sheep equivalents) up to 10 DSE.

Back in the days when it was known as "tree lucerne", tagasaste's use was thought to be limited to drought fodder – for mechanically pruning once a year to keep stock alive. "We've since discovered it can be very successfully set-stocked with cattle," Tim says.

Trees

South-west reforestation trials have shown that a range of eucalypts and pines can lower the watertable by 7 metres and reduce groundwater salinity by 11 per cent. In the same study area the watertable rose by 2 metres in areas established to pasture. Little wonder trees get a lot of attention in the Action Plan!

Eucalypts

Eucalypts are well adapted to the Western Australian environment. After all, they maintained the State's water balance for tens of thousands of years before clearing.

At most sites where tree water-use has been measured, eucalypts showed themselves capable of using at least as much as the annual rainfall.

Until recently tree cropping in Western Australia has centred on bluegums and areas with rainfall over 600 millimetres a year – particularly around Albany where they perform extremely well.

Now maritime pine (*Pinus pinaster*) is available for the 400 to 600 millimetres zone, and for the wheatbelt, oil mallee is being developed.

Maritime pine

Maritime pine is another plank in the Salinity Action Plan. CALM's Richard Moore, from the Busselton office, says it is suitable for areas with rainfall of 400 millimetres up to the bluegum areas of 600 millimetres and over. They can grow from Esperance to Eneabba and inland as far as Narrogin and Katanning.

Projected returns from a hectare of maritime pine, growing at 12 cubic metres per hectare per year are:

- $1000 (at year 12 – first thinning);
- $2000 (year 22); and
- a final dividend at clear-felling of almost $7000.

So far, there are very few private tree crops. CALM has set about establishing plantations in partnership with private landowners, of which 2000 hectares are already planted. An annual planting of 15,000 hectares by the year 2000 is the Action Plan's objective.

Richard concedes that maritime pine does not offer returns as good as wheat, but predicts a major role for it in providing commercial returns for growers who want to reforest for sustainable development purposes and as windbreaks and crop shelter belts.

Oil mallee

CALM is spearheading oil mallee's development as a commercial crop, the success of which hinges on the 'eucoil' which flows from it.

John Bartle, from CALM's Farm Forestry Unit, has been studying tree water use patterns since the early 1980s when he was involved in studies of the impacts of bauxite mining and salinity in water supply catchments.

"By the late 1980s the hunt was on to find species which would make a quid, and which were relevant to landcare and salinity. It had to be a tree with vast markets – the State Salinity Action Plan alone is looking to plant three million hectares of trees!"

Murdoch University had researched oil since the oil crises of the late 1970s when eucoil was contemplated as a fuel additive. CALM picked up that work in 1992.

John says the future for eucoil is not as "...a treatment for coughs and colds and stuffy noses..." – the traditional liniment, lozenge and aroma markets, but as an industrial solvent in cleaners and de-greasers for which the eucoil's cineol component is well suited.

Major changes are afoot in these markets. The once popular chlorinated hydrocarbon-based solvents have fallen from favour because they are ozone depleting. The world solvent market will pay a premium for products with good "green" credentials, John says.

The oil mallee is "...suitable for everywhere" but with an eye to providing a critical volume that is essential for the viability of harvesting and extraction programs, CALM has targeted six areas – north of Morawa, Kalannie, Narembeen, Wickepin, Woodanilling, and Esperance.

So far, six million seedlings have been planted across five thousand hectares and support amongst farmers is very strong. An Oil Mallee Association with 360 members has been formed.

Salt hazard and vegetation change mapping

To understand priorities within catchments and between catchments, and to provide very practical assistance to farmers on the ground, the Salinity Action Plan has reached for the heavens.

Using the technology of Landsat TM satellites, systems are being developed to predict where salinity problems are likely to occur in the future and to document where they are today.

By plotting satellite data going back to 1987 against today's images, the rate at which salinity is spreading is calculated. Along with other data, such as contour maps and known hydrology of catchments, accurate models of what the future holds can also be created.

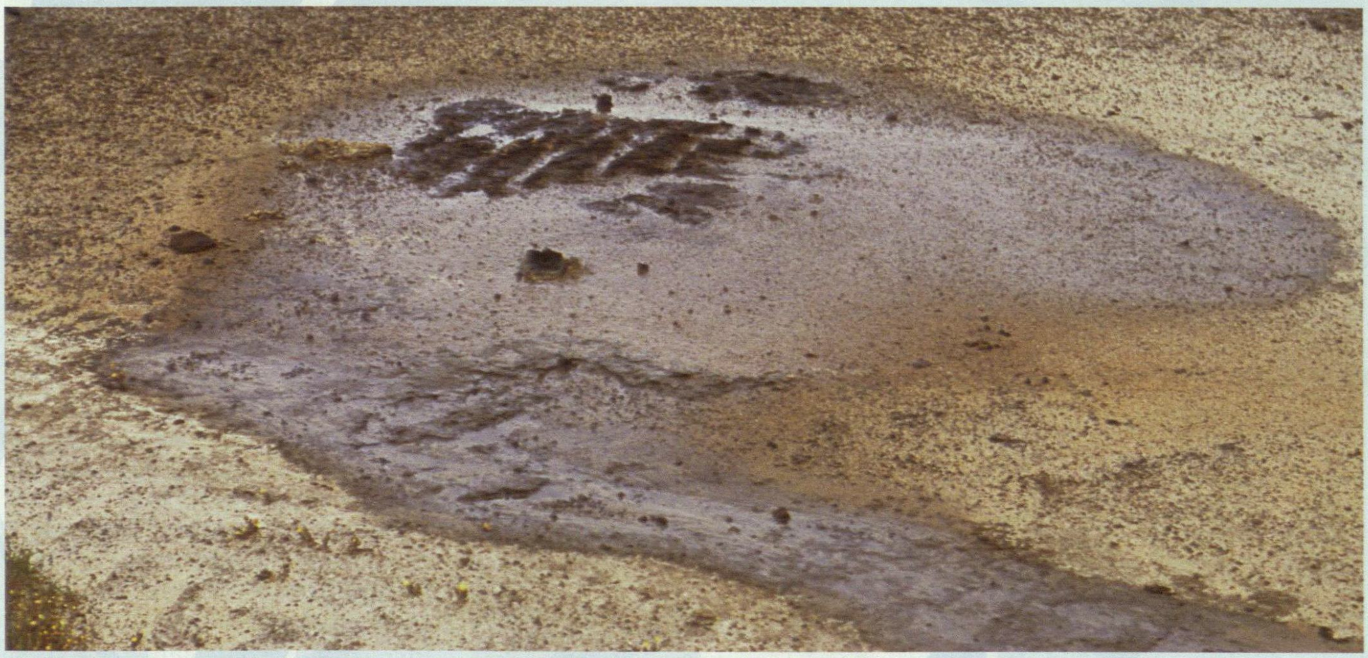
The Kent catchment on the South Coast was used for developing the Salt Hazard Mapping system, a joint effort by CSIRO Division of Mathematics and Information Science, and Agriculture Western Australia.

Sustainable Rural Development Manager for the South Coast, Don McFarlane, says the technique has already been applied with good effect to about 150,000 hectares in and around the Kent catchment and on-going development work is planned.

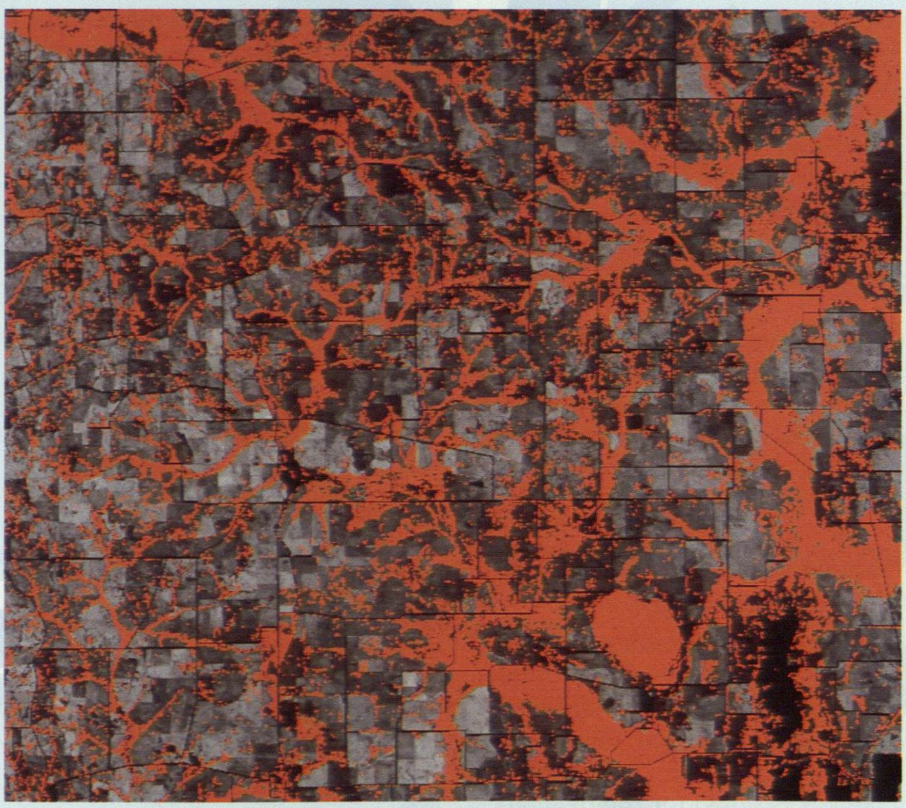
A proposal has been lodged with the Federal Government for the system to be developed as a tool for the whole of the south-west, from Geraldton to Esperance. If accepted, contour, salt and vegetation maps will be available to the whole of the south-west three years after the money comes through. Using existing resources, it will take over 10 years.

Setting priorities – Focus and Recovery Catchments

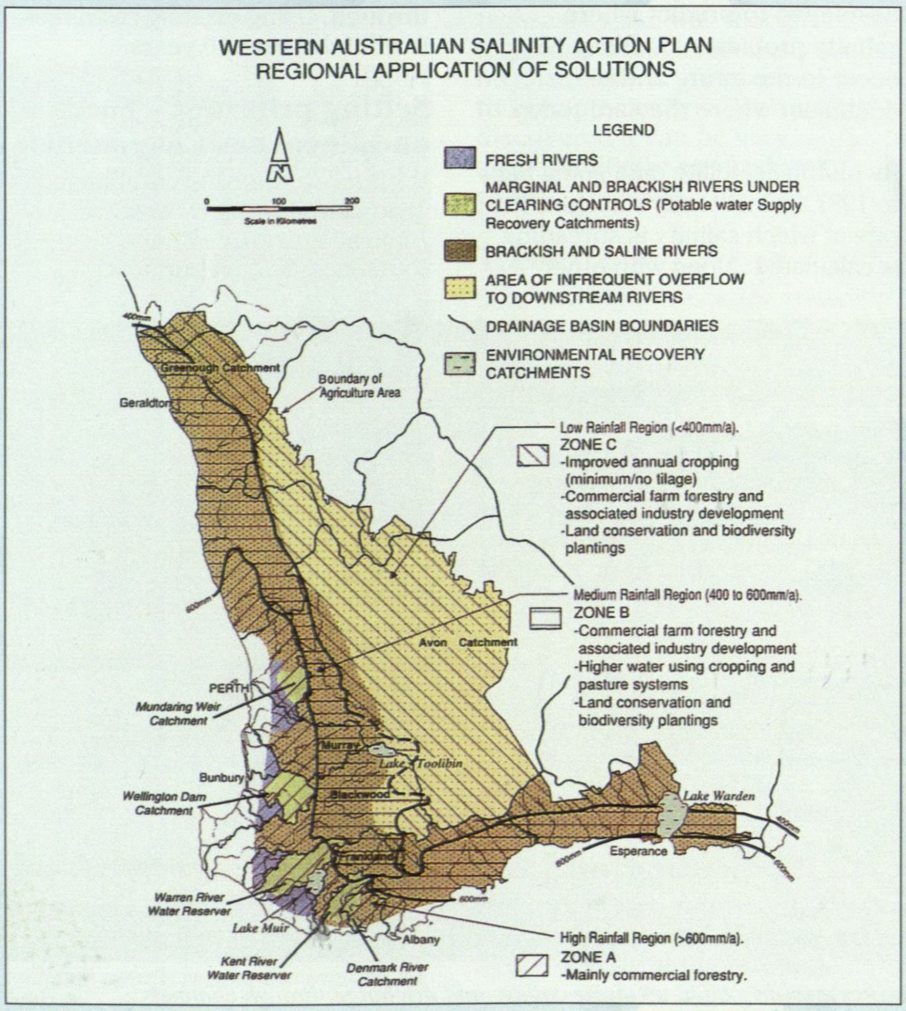
With more than 300 catchment groups operating in Western Australia, priorities have been set to make sure that support



Seepage eye in an old root channel. Groundwater pressures build up under valleys and discharge through channels.



Self affected area in a 45x45 km part of the Moora district mapped using Landsat TM images from 1992 and 1993 and landforms. Self affected areas increased from 14.2% in 1988 to 22.0% in 1994.



services are not spread too thinly. Ultimately all catchments will be addressed under the Salinity Action Plan but initial assistance is being provided through Focus Catchments and Recovery Catchments.

Agriculture Western Australia will support up to 30 initial Focus Catchments, identified by an assessment of the benefits and costs of achieving salinity control, and through a negotiated cost-sharing system. The selected catchments have sub-catchment groups which have completed the planning processes and are committed to implementation.

Recovery Catchments are those where public assets, such as water resources, natural diversity, towns and roads, are at risk from salinity. Where protecting such assets is recognised as a priority, the Government, in consultation with local communities, will develop recovery plans to protect all of the assets in perpetuity.

Regional water use targets

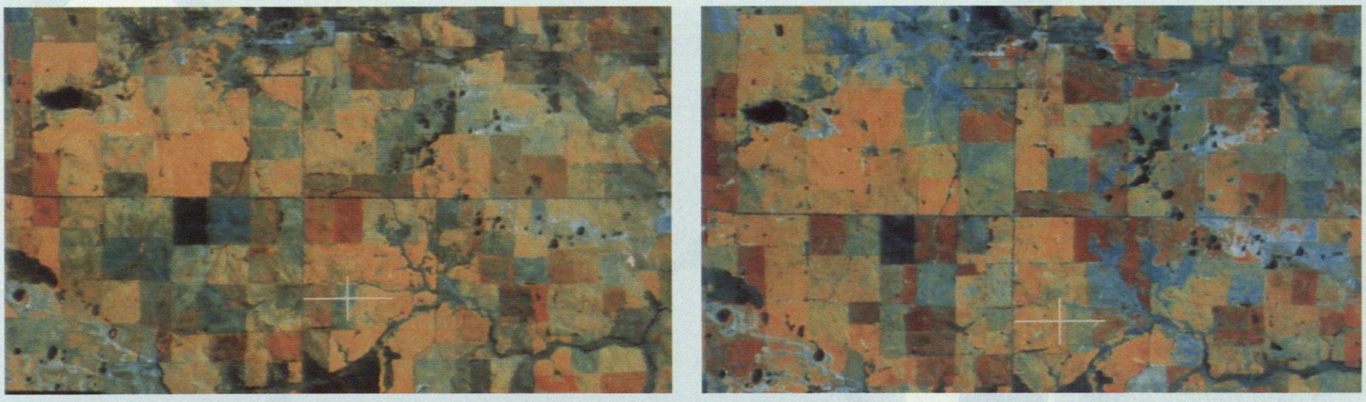
Broad water use targets have been set for various rainfall zones giving farmers a fair idea of what is expected for their area.

For example, in the central and eastern wheatbelt, a 20 millimetre increase in on-farm water use is considered reasonable. The Action Plan suggests this could be achieved, in part, by targeting 15 per cent of total farm area for perennial vegetation – either pasture or trees, possibly commercial tree plantings of oil mallees.

Water balance calculator

Nick-named 'WA'ttle' – what'll happen if ..., this computer software package is being developed by Agriculture Western Australia's Richard George, in conjunction with the University of Melbourne. It will provide water balance calculations for individual farms and is expected to be available on disk by September 1997.

Richard says the calculator has been programmed with a



Landset images showing bare areas (blue) expanding between 1986 (left) and 1990 (right).

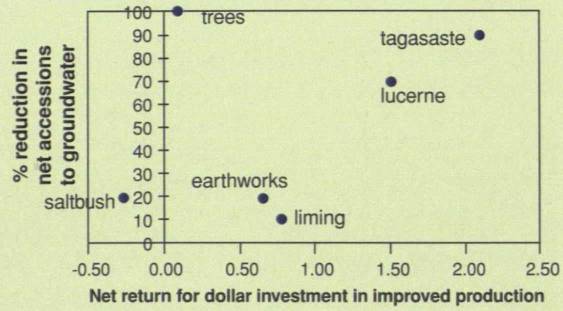


Figure 2. The effectiveness of various management practices in controlling groundwater (vertical scale) and the financial benefit (or cost if negative) to the landowner for each dollar invested (horizontal scale).

comprehensive picture of the State's agricultural areas from Geraldton to Esperance, including 40 years of rainfall and climate data, and indicative local soil types. The water usage patterns of various crops, pastures and trees have also been entered.

By feeding in your local data and experimenting with various crop:pasture rotations, the impact of the water balance optimum system for salinity control on individual farms can be deduced.

$ returns – ready reckoners

Few questions are higher priority than those dealing with the bottom line of projected returns. The Plan presents some answers in ready reckoner-type graphs for the various rainfall zones, such as Figure 2 for the medium rainfall zone – western wheatbelt, 450 to 600 millimetres rainfall.

This graph illustrates the net economic benefit of various water management practices and the degree of groundwater control each might provide. Using these as guides, farmers can make ballpark assessments of their options for managing salinity.

The fate of Western Australia's agriculture, water resources and natural environment depends on acknowledging the lessons of the past and investing in the future. The State simply cannot afford to give up 30 per cent of its agricultural land to salt. Already the problem is costing $64 million a year in lost production.

Fifty years ago, Commissioner of Soil Conservation George Burvill stated: "Soil salinity is a State problem – a problem of all the people of the community, not only of the individual whose farm is affected". His message is as important today as it was then.

The State's Salinity Action Plan, with its wide-ranging strategies and commitment from across many Government agencies, embodies that sentiment.

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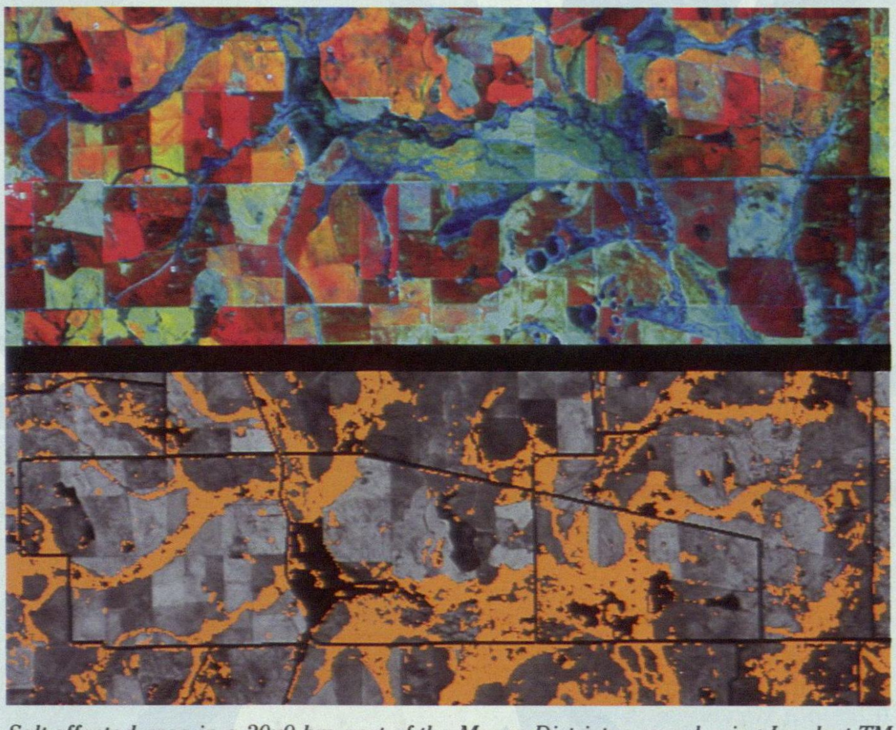

Salt-affected area in a 20x9 km part of the Moora District mapped using Landsat TM images from 1992 and 1993, and landforms. Upper images show saline areas as having little vegetation cover (blue) or lower image showing saline areas (orange). Salt affected area was 18.9% in 1987 and 21.6% in 1993.