# 14. DRYLAND SALINITY

## 14.1 PROCESSES

### 14.1.1 Cause

Salt originates from the weathering of rock minerals, cyclic salts in meteoric waters (rainfall) or from the deposition of oceanic salt in rocks deposited in a marine environment. In healthy catchments, the salt is leached down and is stored below the root zone. Dryland salinity is the result of the upward movement of groundwater- either a rise in the local water table or an increase in the potentiometric pressures of regional confined aquifers, which is responsible for moving the salt to the soil surface (58).

Geological complexity and the salt producing potential of geology are the main sources of salinity in the Little River Catchment (45). Salt can be sourced from igneous intrusions and metamorphosed sediments. Salinisation in dryland areas (non- irrigated) is the accumulation of ions in the soils and groundwater. These ions are:
Sodium - $Na^+$, Potassium - $K^+$, Calcium - $Ca^{2+}$, Magnesium - $Mg^{2+}$,
Chloride - $Cl^-$, Bicarbonate - $HCO^-_3$, Carbonate - $CO_3^{\ 2-}$, and Sulphate - $SO_4^{\ 2-}$.

If soil and water conditions allow the ion concentration to build up, the toxic effect of the salt and excess water in the root zone ultimately prevent vegetative growth, leading to unproductive land. (See Appendix 10.) Once saline groundwater discharges to the surface then salts accumulate and concentrate in the surface soil and watertable through evaporation and evapotranspiration. If the water table is within one to two metres of the ground surface, then discharge occurs through capillary rise. Plants also selectively omit salts during the osmotic uptake of soil water, further increasing the concentration in the soil.

The removal of native vegetation has contributed to the onset of dryland salinity in the Little River Catchment. Previously, native trees and shrubs covered the landscape. The original vegetation had roots spread throughout the soil at a range of depths, providing for maximum interception as drainage occurred down the profile or across the landscape. The vegetation and landuse maps (See Figs 8 and 14) highlight the extensive areas devoid of tree cover and perennial grasses, and now subject to annual crops and pastures. Many pastures have been overgrazed or changed from native to introduced species, based on annual legumes. The excess water in the landscape has led to a reduction in water use and interception and subsequent rising water tables.

Saline discharge is most common in lower slopes and valley bottoms, but may occur in any part of the landscape, depending on geology and groundwater flow patterns. Discharge is the result of either a rise in the local water table or an increase in the potentiometric pressures of regional confined aquifers. See Figures 12 and 13 for the geological conditions that result in discharge of groundwater to the surface.

These conditions do not cause salinity at every site - it is dependent on the geology and landscape processes. (See Section 10 - Hydrogeology) The time taken for these processes in any catchment is poorly understood and very difficult to predict. It is necessary to know what is driving the process in order to make appropriate management recommendations, although the basic principle of "use water where it falls" applies in all cases.

### 14.1.2 Upstream/Downstream Inter-Relationships

Clearing of vegetation and "leaky farming systems" has led to rising watertables, which can result in saline scalds, waterlogging and potential erosion sites. A "leaky farming system" is when cropping or grazing systems do not utilise the soil water available and deep drainage occurs below the root zone. Dryland salinity can lead to increased levels of erosion due to loss of groundcover, which in turn leads to increased sediment load and salt concentration in the river system. Acidification, which is prevalent throughout the district weakens or restricts plant growth, resulting in further reduction in the use of soil moisture.

In the upper catchment a direct link has been established between dryland salinity sites and increasing salt loads in the river system. It has been estimated that Little River contributes approximately 12% of the salt load of the Macquarie River at Dubbo (40). It was estimated in *Salt Trends* (1997) that approximately 206 tonnes of salt per day passes through the Macquarie River at Dubbo (43). The DLWC measurements from mid December 1998 to mid May 1999 show an average daily reading of 400 tonnes of salt / day at Dubbo.

This salt load poses an alarming threat to downstream water users and irrigators who extract river water and apply it to the land. If dryland salinity continues to develop in the uplands, the salt load in the river system will continue to rise. The MDB Audit highlights the extent of the salinity risk from the Macquarie (See Section 16- Surface Water Quality and Quantity). Saline water will reduce the potential yield of irrigated crops and may also reduce the range of crops able to be grown.

High salt loads in the Macquarie River will also affect the health of the Macquarie Marshes, the Darling River system and town water supplies along both the Macquarie and the Darling Rivers. Roads and other infrastructure, including plumbing, foundations, corrosion of plant, machinery and household items and lack of suitable water for industry are all off-site impacts of dryland salinity.

## 14.2 PRESENT CONDITION

### 14.2.1 Distribution and Severity

There are numerous known salinity outbreaks in the Little River Catchment. The main areas affected within the catchment are south west of Cumnock, Yeoval subcatchment, east of Baldry, and east of Arthurville and Suntop. (The true extent of salinity in the Baldry subcatchment is unknown as the data for approximately 57000 hectares of the catchment has been surveyed but not digitised for GIS maps and statistics. This includes the area around Yahoo Peaks, regarded as one of the worst sites in the district).

When the land degradation study was undertaken (1988 aerial photographs), the Wellington 1:100 000 sheet had by far the highest incidence of dryland salinity in the Macquarie valley. In 1988, less than 0.12% of the Upper Macquarie Catchment was affected by dryland salinity. In comparison, 0.41% (1075 ha) of the Little River was affected (13). The area affected by salinity in the catchment has increased at least fourfold over the last decade to 4408 ha (not including west of Baldry) (48). Some locations in the catchment have concentration levels high enough to be constantly affected by salinity and nearly 40% of the affected area has reached the stage where salt tolerant species replace salt sensitive species (13).

Of farmers surveyed in the Little River Catchment, 80% believe that salinity is a moderate to serious problem. The majority of these farmers believe that the problem is worsening (40). Figure 16 shows known saline sites in the catchment in 1998 and 1988 and Table 14 gives the area and distribution of these sites.

**Table 14: Areas of Known Saline Sites in Little River - 1992 and 1998**

| **Salinity** | **Baldry** | **Yeoval** | **Cumnock -Little River** | **Cumnock -Bell River** | **Suntop/ Arthurville - Little River** | **Suntop/ Arthurville -Bell River** | **TOTAL** |
|---|---|---|---|---|---|---|---|
| 1992 - known salinity | 274 | 173 | 260 | 9 | 306 | 52 | **1074** |
| 1998 - known salinity | 779 | 859 | 1081 | 99 | 1175 | 415 | **4408** |
| 1998- % of area | 0.70* | 2.37 | 2.87 | 1.58 | 2.21 | 3.04 | **1.706** |
| 1998 - no known salinity | 53069 (57236 unmapped) | 35407 | 36640 | 6169 | 52112 | 13231 | **253914** |
| **1998 TOTAL** | **111134** | **36266** | **37721** | **6268** | **53287** | **13646** | **258322** |

***** only 49% of the Baldry subcatchment was mapped

Currently the tributary catchments of the Macquarie River export an average of 12 tonnes/km$^2$ per year. Bell River (of which Curra Creek is a tributary) and Buckinbah Creek have the highest export rates of 19 and 18 tonnes per kilometre square per year respectively. The average is predicted to rise to 23 tonnes per year within twenty years (63). Salt concentration is dependent on seasonal conditions and river flow. This can be seen in Figures 9a -c in Section 9 - Surface Water.

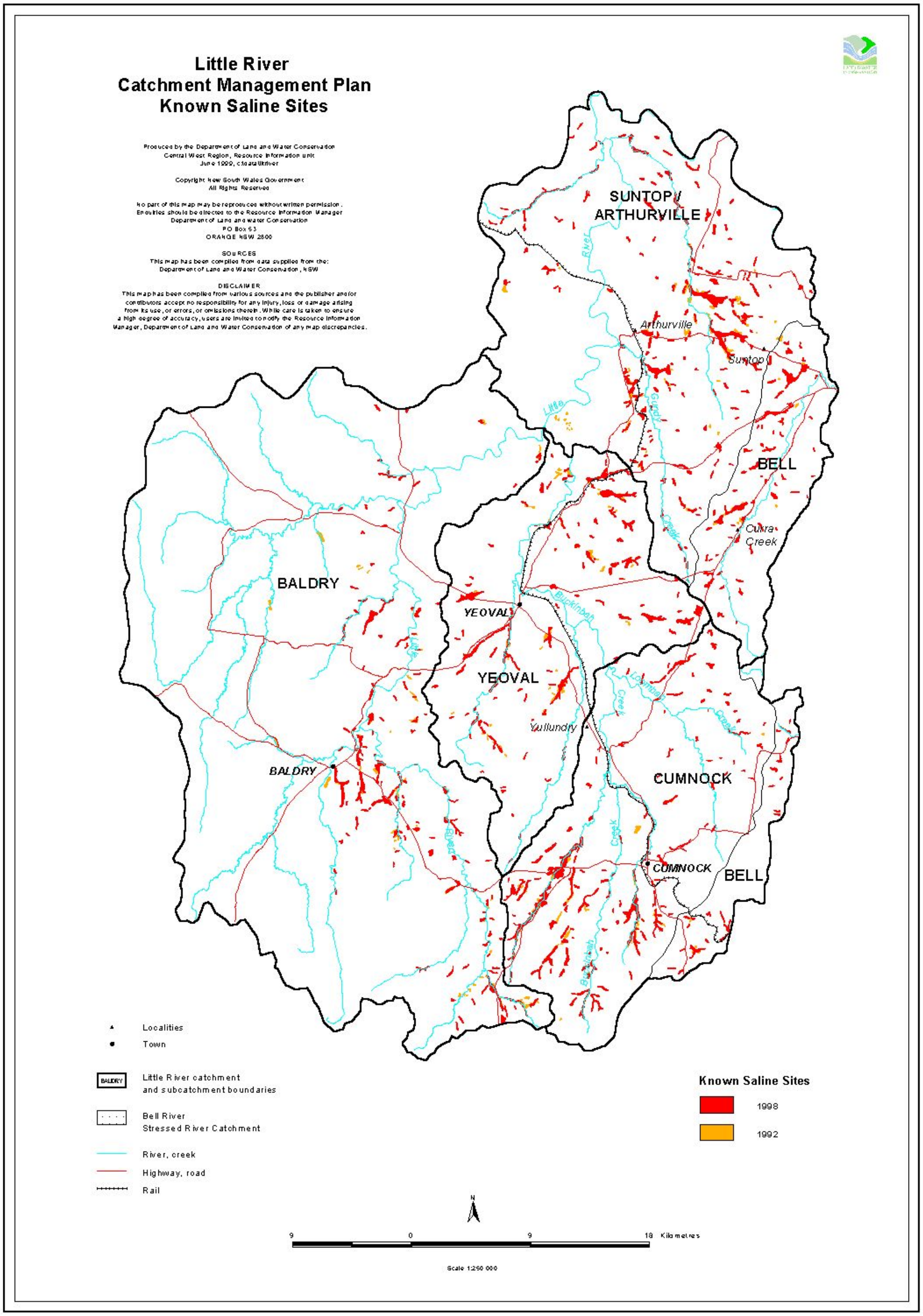
The Central West Catchment Salinity Risk Assessment has classified the Little River Catchment with a very high salinity hazard rating. This is mostly due to geological complexity and the salt producing potential of lithology (59).

A brief review of the findings of two case studies is provided below. More detailed reviews are found in Appendix 6. Project work has also been undertaken in the Yahoo Peaks (Jenny Lane) and currently in the Arthurville area (Nahla Matti). A key finding of both these studies is that salinity in these areas is the result of a locally driven system.

<u>Suntop Area - T. Callen (2)</u>
A number of saline scalds in the Suntop Landcare area are found along the ephemeral drainage lines. These were both visible on the ground and apparent from the EMI survey. There are four "hotspots" in the area as identified by EMI, although the EMI readings have not been corrected for water and calcium content. The EMI survey also identified some potentially saline areas to the north west, which are not currently showing visible signs of salinity. These should be monitored regularly.

The hydrogeology analysis suggests that salinity is due to a local groundwater system, and can be controlled by local measures including planting salt tolerant species and possibly with tile drainage in the discharge zones, and replacing the trees on the recharge zones. Pumping the watertable into the creek is not an option as the creeks are already salty, and this approach would increase salt loads in the major drainage systems. Callen thought the most likely source of salt was NaCl from rainwater, with salts from the marine sediments a secondary source.

**Figure 16: Known Saline Sites in Little River**



Upper Buckinbah - G. Kazemi (50)
Dryland salinity occurs on five properties (out of 12) in the catchment. It is caused by recent landuse changes and is the result of a locally driven groundwater system. The main sources of salt into the Buckinbah Creek is from the upper catchment. The Upper Buckinbah Catchment is in the early stages of the salinisation cycle, and further rises in watertables could be expected to lead to increased soil and stream salinity.

Kazemi considers the salts in the stream are probably of more concern than the impact on the land, and this is made worse by high evaporation leading to concentration of salts in farm dams which then overflow sending a spike of salt into the system. Additionally, the saline shallow aquifer provides base flow to the stream. In the wet seasons, the salinity levels in the stream are higher than during dry periods, when the baseflow is entirely derived from deep groundwater. Periods of high rainfall increase discharge, and also dissolves the previously evaporated salt from the surface and washes it into the streams. After a period of wet conditions, the salt concentrations decline due to flushing.

The off-site impacts on streams and bore water is more significant than the on farm cost. Kazemi suggests that remedial action would not be cost effective for local farmers. However, remedial works need to be viewed in light of the downstream impacts on river water quality into the Macquarie and Murray-Darling Basin systems. Action should be taken now while it is in early stages of salinisation, and the possibility of reversal is higher and less costly.

### 14.2.2 Environmental Impacts

Environmental impacts of salinisation include (40):
- decline of native vegetation
- loss of food sources for wildlife, increased erosion
- loss of wetland habitat
- impact on stream and wetland ecology
- loss of aesthetic value
- loss of recreational and tourism values
- reduced biodiversity
- damage to national parks and
- loss of nesting sites.

Salinity is unlikely to have a significant effect on native vegetation, because the vast majority of the remnant vegetation is found in the Goobang National Park, where no salinity has been reported. However, there is some very visible dieback along drainage lines due to salinity. Although this is a very small proportion of the catchment, it can have a very significant impact on riparian health and biodiversity.

Salinity in the Little River area is generally apparent by the loss of sensitive vegetation and the growth of more salt tolerant species in their place. Some salt scalds also occur in these areas. Some areas also experience erosion as an effect of salinity.

The full extent of the problem in the catchment has not yet been realised. A large amount of the salt load in the Macquarie River is being deposited in the Macquarie Marshes which has impacts on species diversity and composition (62). (See Section 9 - Surface Water). The long term effects are unknown, but the loss of ecosystem services and tourism income would have a large impact to the surrounding community and to biodiversity. (See Section 17 - Riverine Environment).

### 14.2.3 Social and Economic Impacts

A recent study commissioned by MDBC and undertaken by Ivey ATP from Wellington showed that the total annual costs to the entire catchment is $1 667 563. This covered the following aspects of salinity:

- Watertables at or near the surface
- Saline groundwater eg bores and wells
- Saline surface water eg rivers and dams
- Saline soil conditions

The costs included lost production and remediation, infrastructure repairs and maintenance, preventative works and shortened lifespan of infrastructure, changed management practices, foregone income, increased operating costs, education and research and loss of property value. See Table 15. However, it did NOT account for the off site impacts i.e. downstream effects to irrigators, town water supplies and the Macquarie Marshes.

**Table 15: Estimated Costs of Rising Water Tables and Salinity in the Little River (40)**

| Type | Annual Cost $ | % |
|---|---|---|
| Farmers | 770,743 | 46.2 |
| Households | 177,943 | 10.7 |
| Businesses | 39,097 | 2.3 |
| Councils | 74,188 | 4.4 |
| Agencies | 392,816 | 23.6 |
| **TOTAL** | **1,454,787** | |
| Reduced property values | 212,777 | 12.8 |
| **TOTAL** | **1,667,564** | **100** |

This information was obtained from interviews and surveys of various landholders, businesses, councils and government agencies.

It has been estimated that rural property values in the Little River Catchment have fallen by $102 973 per year. The total annual cost of salinity and high watertables is $5.31 per hectare of farmland. Urban household costs are $530 per household per year. The rural areas incur 80% of the cost of salinity and high watertables (40). Table 16 provides a summary of the cost of dryland salinity to various sectors of the community in the Little River Catchment.

**Table 16: Summary of Costs of Dryland Salinity in Little River by Community Sector**

| Types of Costs | Farmers | House hold | Business | Councils | Agencies | Total |
|---|---|---|---|---|---|---|
| Repairs & Maintenance | 234483 | 88527 | 26965 | 58821 | 25553 | 434349 |
| Increased Cost of New Infrastructure | 70003 | 9226 | 2300 | 13233 | | 94762 |
| Preventative Works | 256781 | 24015 | 5067 | 2133 | | 287996 |
| Reduced Lifespan of Infrastructure | 30720 | 40799 | 540 | | | 72059 |
| Increased Operating Costs | 47904 | 15377 | 4225 | | | 67506 |
| Foregone Income | 130852 | | | | | 130852 |
| Education Research etc | | | | | 367263 | 367263 |
| **Total Annual Costs** | **770743** | **177944** | **39097** | **74187** | **392816** | **1454787** |
| Reduced property values | 102973 | 109804 | | | | 212777 |
| **TOTAL** | **873716** | **287748** | **39097** | **74187** | **392816** | **1667564** |

## 14.3 THE FUTURE
### 14.3.1 Trends

Given that most of the catchment is based on marine sediments or metamorphosed geology, there is a high potential for salinity to affect large tracts of the catchment. The time period between the clearing of vegetation and the appearance of symptoms of salinity is between 60 and 80 years and most of the catchment has been subjected to some form of clearing. Kazemi concluded that the Upper Buckinbah Catchment was in the early phase of salinisation, and this could be the case across the catchment.

The MDBC has set three threshold salinity levels (800, 1500 and 5000 EC) against which the severity of salinity can be gauged. (See Section 16 - Surface Water Quality and Quantity).

The Macquarie River faces sharp rates of increase in salt loads and salinity levels in future years. The MDBC Audit has predicted that by 2020, the 800 EC level (drinking water) will be exceeded and by 2050 the 1500 EC level will have been exceeded. By 2050, it is expected that the Little River catchment will be contributing more than 50 tonnes salt / $km^2$ to the river system (62). It has been predicted that 5 million hectares of land in New South Wales could be affected by dryland salinity if no action is taken (45).

### 14.3.2 Projected Environmental Impacts

The severity of the effects of salinity is set to increase because many saline sites in the catchment have only become apparent in the last ten years. Salinity levels in the Macquarie River downstream of Dubbo are increasing by 2% each year. (44) Salt loads in the river are expected to double in the next twenty years. Dryland salinity in the upper Macquarie catchment needs to be controlled in order to prevent further salinity problems downstream. Salt levels in the Macquarie Marshes in the future could cause a loss of species diversity and composition and the potential for salt scalding as salt concentrations increase (62). No studies have been undertaken to determine the effects of salt on the terrestrial environment. Despite investments into developing improved farming systems and catchment management plans, in some areas there are currently no farming systems capable of controlling salinity (62).

### 14.3.3 Projected Social and Economic Impacts

The loss of productive land due to salinity will have serious effects on landholders. There will need to be new farming systems introduced that prevent the leakage of water and nutrients below the root zone. Stocking numbers may have to be reduced if land is no longer in production, or saline agronomy may be implemented if landholders are to remain financially viable. There are potential social impacts if landuse change eg large scale timber plantations, takes place on a large scale in terms of population dynamics. However, this could also be the case if nothing happens, as the land will be unable to support the current numbers of families within the area.

Historical costs of salinity are useful for estimating the costs of salinity in the short term. However, long term estimates have not been attempted because factors affecting salinity and high watertables may change (40). As salinity levels continue to increase, water quality will deteriorate to below the safe drinking water standards in urban areas and will also affect irrigation areas and wetland ecosystem health. This will cause social problems and high costs to Local Government as there will be increased treatment costs for drinking water and other problems from salinity may reduce the availability of other resources (62). The costs of remediation and loss of production can be expected to rise significantly over time.

## 14.4 CURRENT ACTIVITIES
### 14.4.1 Planning

The State and Commonwealth governments and the MDBC are extremely concerned about the spread of dryland salinity. The MDBC is developing a strategic response to the Salinity Audit, and announcements are expected from the Federal Government. The NSW State Government held a forum in Dubbo in March 2000 to respond to the Audit, and the NSW Salinity Strategy is due for release in July 2000.

The Central West Catchment Management Committee is producing a Salinity Strategy in order to prioritise actions and allocate funds. The Wellington Dubbo Landcare Management Group is also currently developing a Regional Management Plan. This Catchment Management Plan for the Little River Catchment should place the LRLG in a strong position to attract resources and implement programs to combat salinity and other resource management issues.

### 14.4.2 Research and Development

Numerous research and development programs have been or are currently being undertaken to better understand the causes of and solutions to dryland salinity. Only the outcomes of projects specifically relating to Little River have been included, as the generic projects are far to numerous to mention. The Hydrogeological Assessment for Salinity Landscape Management (HASLAM) project has funded several masters and PhD projects within the Little River Catchment - Suntop, Upper Buckinbah, and Arthurville. These focus on the causes and remediation of salinity in specific areas. (See Appendix 5)

A very large investment in research is being made through the National Dryland Salinity Program (NDSP), through LWRRDC in conjunction with GRDC and many other cooperators, including MDBC. MDBC commissioned Ivey ATP to analyse the Costs of Dryland Salinity in the Little and Talbragar River Catchments.

The Salt Action Program in New South Wales also provides funding for salinity related research and implementation and has funded DLWC to run a number of trials including salt tolerant species trials, salinity hazard mapping, piezometer monitoring and electromagnetic induction surveys. The LWRRDC Research Program - Redesigning Agriculture for Australian Landscapes, is investigating new farming systems, which do not leak water and nutrients.

The known local research and investigation projects in recent times are listed below:

- HASLAM Projects
- Saline Site Classification Work and mapping
- Yahoo Peaks project – Topographic modelling, implemented action plan, monitoring
- Saltbush trials – (Suntop) DLWC & NSW Ag.
- Central West Native Grasses Program– Establishment and harvesting of natives, including Warrego grass and bambatsi panic (summer species).
- Salt tolerant pasture trials - Cundumbul, Parkes, north of Wellington, Myrangle.
- Farm Forestry - Acacia trials for timber (Suzette Searle - CSIRO) (Cundumbul, Eurimbla, Burgoon and Myrangle Landcare Groups)
- Direct Seeding Trials - SA Woods and Forests
- Farm Forestry species trials - Arthurville

### 14.4.3 Implementation

Electromagnetic Induction surveys have been completed for the Saddleback, Myrangle, Burgoon, Hervey Ranges, Suntop, Arthurville, Yahoo Peaks Landcare Groups. The Yeoval Group is to be surveyed soon. Only the Hervey Ranges report has been finalised.

Piezometers have been installed at Arthurville, Burgoon, Myrangle, Saddleback, Suntop, Yeoval, Yahoo Peaks, and Hervey Ranges Landcare Groups.

The Yahoo Peaks Project was an implementation trial on twin catchments - one side treated, the other left untreated. The results are quite visible, and were monitored over time, including water table height in piezometers.

Many of the 14 Landcare groups have accessed external funds to undertake remedial and preventative activities - Burgoon, Central Yeoval, Eurimbla, Hervey Ranges, Merry Glen, Middle Arm, Myrangle, Obley, Saddleback (substantial), Suntop, Upper Buckinbah, Yahoo Peaks (substantial), and Yeoval. (See Landcare Directory - 67). The Landcare Coordinators are currently updating this directory.

### 14.4.4 Monitoring and Evaluation

DLWC is finalising the Known Saline Sites Mapping in the district. This updates the previous work, which was part of the 1:100 000 Erosion and Land Use Survey 1989-92.

In 1996, ABARE surveyed the costs of salinity to Local Government over the entire MDB. This data has been much improved for the Little River area by the Costs of Dryland Salinity Survey by Ivey ATP (40). The Murray Darling Basin Salinity Audit has also just been completed, which gives an excellent account of the current and projected situation for dryland salinity.

However, monitoring at the local level is poor. While there have been a large number of piezometers installed there is no regular monitoring on the majority of these - the exceptions being at Arthurville and Yahoo Peaks and one property at Myrangle. Seven Electromagnetic Induction (EMI) surveys have also been undertaken within the catchment and preliminary results have been discussed with the Landcare Groups. However, these have not been ground-truthed and calibrated through laboratory testing. They will need to be repeated in the future to be a monitoring tool.

### 14.4.5 Best Management Options (BMOs)

Best Management Options are well advanced for management of dryland salinity. Dryland salinity must be treated on a catchment basis to have any form of success. The catchment "scale" is dependent on whether the groundwater system is regionally or locally driven.

The principles are well established, but implementation is limited by lack of knowledge of the hydrogeological processes in each location, and the extent of implementation required to arrest the spread of salinity and control rising water tables. The time lag between implementation and impact may be too long to actually achieve the desired outcome.

General principles for dryland salinity management are (65):

- Reduce recharge
  - Opportunity or response crop where possible, and rotate with perennial pastures
  - Plant trees, particularly in recharge zones
  - Plant deep rooted perennial pastures
  - Revegetate stock routes, fence lines and geomorphic boundaries
- Intercept water in the transmission area
  - Construct subsurface drainage (unlikely in Little River)
  - Plant dense vegetation belts with high water use species
- Increase water use in discharge area
  - Revegetate the area with perennial, high water use, salt tolerant vegetation
  - Construct subsurface and surface drainage
  - Pump into evaporation basins
  - Plant halophytic species eg saltbush in high salinity areas
- Manage the existing situation
  - Maintain vegetation and tree cover
  - Fence out affected areas
  - Improve surface drainage
  - Plant salt tolerant species and deep-rooted plants.

### 14.4.6 Identified or Perceived Barriers

The lack of specific information on the hydrogeological processes on both small subcatchment and regional scale means that there is a lack of certainty of the outcome of implementation programs. Deep monitoring bores have not been installed (only shallow piezometers) so no data is available on the direction of flow of groundwater systems.

Financial viability may prevent some farmers from undertaking preventative and restorative measures. Given the high costs and long timeframe for response to tree planting programs, this is a real concern. Management changes with shorter response periods such as pasture establishment also have high risks e.g. establishment failure and severe impacts on cashflow, including large up-front costs, income foregone until the pastures are useable and the costs of purchasing additional stock and maybe fencing and watering. Producers need to know that the benefits of fixing the problem outweigh the costs and they will still be viable after the change.

Dryland salinity is an external impact to many farmers, who may not be directly affected themselves, nor are they aware they may be causing impacts in other places. There is a real impediment in terms of how to achieve cost sharing and equity for all residents in the community. This problem will need to be addressed before unaffected upland farmers are willing to participate.

Despite the almost equal distribution of summer and winter rain in the district, the cropping systems are based on winter /spring growing period, with very few summer crops grown. As well, native pastures are degraded, and summer grasses no longer constitute much of the sward. Farming systems are required that will make better use of summer rainfall to prevent deep drainage, especially in wet summers.

### 14.4.7 Institutional

There are a number of pieces of legislation, which relate to the causes or impacts of dryland salinity. These include the Native Vegetation Conservation Act 1997, Australian Water Quality Guidelines, Protection of the Environment Administration Act 1991, Catchment Management Act 1989, Murray Darling Basin Act 1992, Soil Conservation Act 1938 and the Clean Waters Act 1970.

Institutional arrangements for the implementation of Management Plans have been identified for irrigation areas. However, to date the NSW government has not signed off on a plan in a dryland area. This is at least partially due to a lack of agreement on an acceptable organisational structure or process to administer the resources and cost sharing arrangements in an area without a tool such as water allocations, and to enforce the process once it is implemented.

### 14.4.8 Investment

Significant investment is being made into dryland salinity. Programs include the NHT, National Dryland Salinity Program through LWRRDC, MDBC 2001 and the NSW Salt Action Program. In addition, landholders, local government and some corporate sponsors are investing quite large sums of money into the prevention and control of salinity. However, these latter funds are usually used in discharge areas, and may not be impacting on regional groundwater systems.

It has only recently been acknowledged that this problem is much wider than a rural problem and the massive agricultural and value adding production that comes from the MDB is at risk if quality water is not available. Much greater sums of money and incentives from all sectors, including the urban community, will be required if massive increases in salinity and production losses are to be avoided.

### 14.4.9 Cost Sharing

The MDBC has proposed a cost sharing framework for the investment of funds. Cost sharing requires the identification of roles and responsibilities, and also who benefits, who pollutes and who should pay. The costs can be shared between all tiers of governments, landholders and other resource managers and other beneficiaries including the wider community i.e. metropolitan and regional urban residents. At present, 80% of costs of dryland salinity are being borne by the rural community in Little River (40). However, urban costs are rising and declining water quality will impact severely on households, irrigators and industry.

Better information of the costs of salinity is required before cost sharing models can be successfully developed. The costs of dryland salinity will not always be borne by those who cause them, unless some mechanism is put into place to redistribute those costs. This requires knowledge of the distribution of costs both geographically and by community sectors. Quantification of the costs is an important phase of this catchment plan.

### 14.4.10 Financial and Benefit Cost Analysis

The Salinity Audit has identified that there is a need for better estimation of cost, impacts and the benefit/cost ratios of taking action to solve the salinity problem (62). The on farm costs associated with dryland salinity in Little River is $5.31 per hectare of farmland. The biggest part of this cost is attributed to high watertables resulting in increased repairs and maintenance costs, preventative measures and new infrastructure costs.

Costs to urban households in the Little River Catchment are equivalent to $530 per household per year. Reduced property value is the biggest cost in urban areas. Local councils and non-farm businesses also incur costs associated with salinity. It can be assumed that the costs associated with salinity are going to rise as the problem becomes worse and affects more areas.

## 14.5 ANALYSIS

### 14.5.1 Identified or Perceived Gaps

Data for the "1992" Known Saline Sites came from the Land Degradation survey, which used 1988 aerial photographs. The data for the 1998 survey was collected by on-ground inspection. There are problems with correlations between the two surveys and this may be due to areas being missed or overlapping in either survey. Additionally, the Forbes and Narromine 1:100 000 sheets have not yet been digitised by the GIS, so no data is available for one third of the Baldry subcatchment.

The lack of surface watertable data, despite the investment in installing piezometers, and deep bore data severely limits the capacity to understand or predict what is happening in the catchment. Collection of this data should be an urgent priority of the Little River Steering Committee and DLWC. A simple, on-farm monitoring sheet could be developed to assess salinity trends and changes, with some incentive to return the sheet to a central point for collation and analysis.

The Salinity Audit determined that there is inadequate understanding of the potential environmental impacts of salinity, and the ability to estimate future costs. Projected impacts are mostly based on losses to floodplain wetlands and riparian values from projected salinity levels. In the case of salinity in the Little River, these could be substantial if the Macquarie Marshes are detrimentally affected. The scale and nature of impacts on the terrestrial environment cannot yet be determined. Studies need to be undertaken to understand the full impact of dryland salinity and its costs, and a means of estimating environmental values established.

### 14.5.2 Key Stakeholders and Contacts

**Department of Land and Water Conservation**
Alan Nicholson - Salinity Investigations Officer, Wellington
Helen Wheeler - Salinity Technical Officer, Wellington
Elita Humphries - Salinity Strategic Planner, Wellington
Rob Muller – Salinity Hydrogeologist, Cowra
Ann Smithson - Hydrogeologist (dryland salinity), DLWC, Dubbo

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