MURRUMBIDGEE RIVER VALLEY

An Overview of Dryland Salinity

Preliminary Assessment

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SYNOPSIS

Dryland salinisation is one of the most significant land degradation issues facing the mid and upper Murrumbidgee Valley. The clearing of native vegetation and its replacement with crops and pastures has resulted in increased groundwater accessions and a consequent rise in watertables. This has caused the developing salinisation of arable land and the saline contamination of streams.

A number of organisations are actively involved in understanding and addressing the salinity problem. Major projets such as the Yass Valley Soil Conservation Project have a multipurpose role in research, monitoring, investigation and demonstration of various aspects of secondary salinisation. A number of other smaller projects and investigations are also underway within the Murrumbidgee River Valley. The organisations involved are Soil Conservation Service, Department of Water Resources, CSIRO, Universities, Department of Agriculture, Lndcare groups, consultants and possibly others.

Progress to date has developed a reasonable understanding of the problem on which a basic strategy for the control and management of salinisation has been formulated. However, there is still a need to continue on with research and investigation to fill in shortfalls in our knowledge of salinity and develop our management options.

The implementation of salinity abatement strategies requires the integration of a diverse range of information and successfully passing this on to the community. An important aspect of this is the development of integrated demonstration sites for salinity control and management.

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ABBREVIATIONS AND NOTES

m	metres
mm	millimetre (10^{-3} metres)
ha	hectares (10^{4} square metres)
yr	year
NSW	New South Wales
CSIRO	Commonwealth Scientific & Industrial Research Organisation
ANSTO	Australian Nuclear Science & Technology Organisation
NRMS	Natural Resource Management Strategy
DWR	Department of Water Resources
SCS	Soil Conservation Service of NSW

MURRUMBIDGEE RIVER VALLEY
DRYLAND SALINITY - OVERVIEW

1. Introduction

Dryland salinity has developed into one of the most important land degradation issues within the mid and upper Murrumbidgee River Valley. Rising watertables and saline discharge have degraded the landscape by destroying soil structure and vegetation which cannot tolerate saline and/or waterlogged conditions. Salt degraded land is often left barren, rendering the area susceptible to erosion and further degradation.

Dryland salinity within the Murrumbidgee Valley is a growing problem, with new sites appearing each year and the known ones expanding. The impacts of salinisation are significant in both physical and economic terms, necessitating the development of strategies to address the continued development of salinity and rising watertables.

This paper provides a brief overview of the dryland salinity problem. It looks at the extent of salinisation and gives a basic description of the processes involved. This is followed by a summary of the work being undertaken within the Murrumbidgee Valley to address the problem of dryland salinity. The final sections discuss the progress made to date in investigations and management as well as the problems being encountered, which leads to recommendations concerning future directions in addressing the dryland salinity problem.

This report is a preliminary study of dryland salinity within the Murrumbidgee. Its aim is to provide a base on which to identify some of the ongoing requirements in addressing the problem of dryland salinity and watertable rises.

2. Salinity in the Murrumbidgee Valley

Following is a brief description of the salinity problem within the Murrumbidgee River Valley.

Figure 2.1 is a location map for the Murrumbidgee River Valley. Saline sites in which the Soil Conservation Service are involved are located at Cootamundra, several sites around Wagga, Holbrook, Narrandera, Gundagai and a major project underway in the Yass Valley.

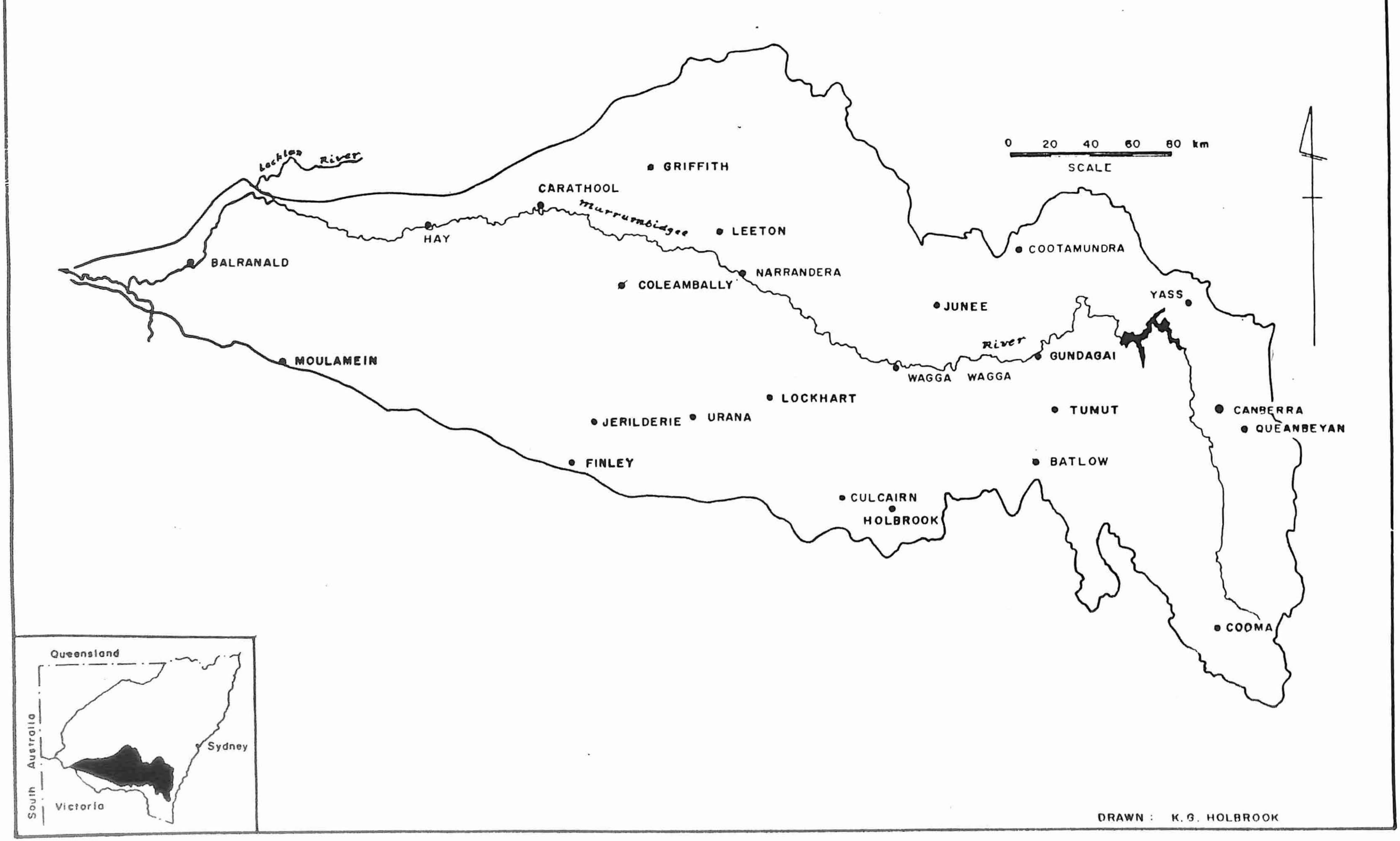
The full extent of degradation due to dryland salinity within the Murrumbidgee is the subject of a current mapping program by the Soil Conservation Service. This is expected to be completed by June 1991. At this stage, comments regards the extent must be general.

In 1982 it was estimated that there were 4,000ha of land affected by salinisation in NSW. By 1988 this estimation had grown to 14,000ha, partly through the development of new areas and the identification of salinity through better awareness. The natural growth of salinisation is estimated at between 10% and 15% each year.

The land degradation mapping undertaken so far has shown a large number of previously unrecorded saline areas and indicate that the mid and upper Murrumbidgee Valley is one of the main areas affected by dryland salinity within NSW.

MURRUMBIDGEE RIVER VALLEY

FIGURE 2·1 : LOCATION



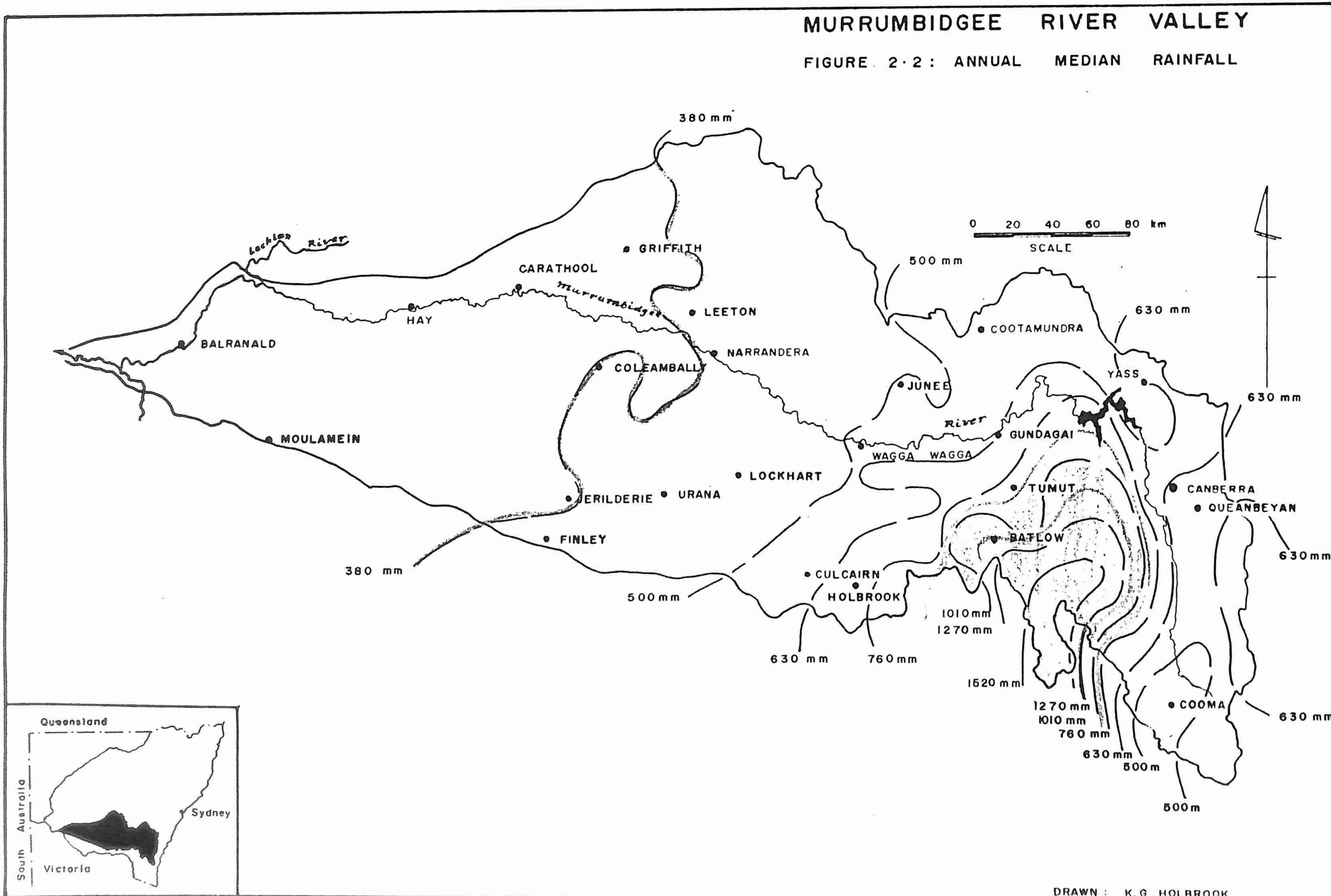
DRAWN : K.G. HOLBROOK

Dryland salinity does not confine itself to any particular environment. Figures 2.2 to 2.4 show rainfall, geology and soils of the Murrumbidgee. Salinity can be cited in a range of geological, geomorphological, agricultural and climatic settings, although it is generally concentrated to areas between the 400mm and 800mm isohyets.

The area west of the 380mm isohyet is subject to 'arid land salinity'. Areas around Hay have been degraded by the exposure of saline subsoils through topsoil erosion. Appendix A provides a brief summary of the development and treatment of arid land salinity.

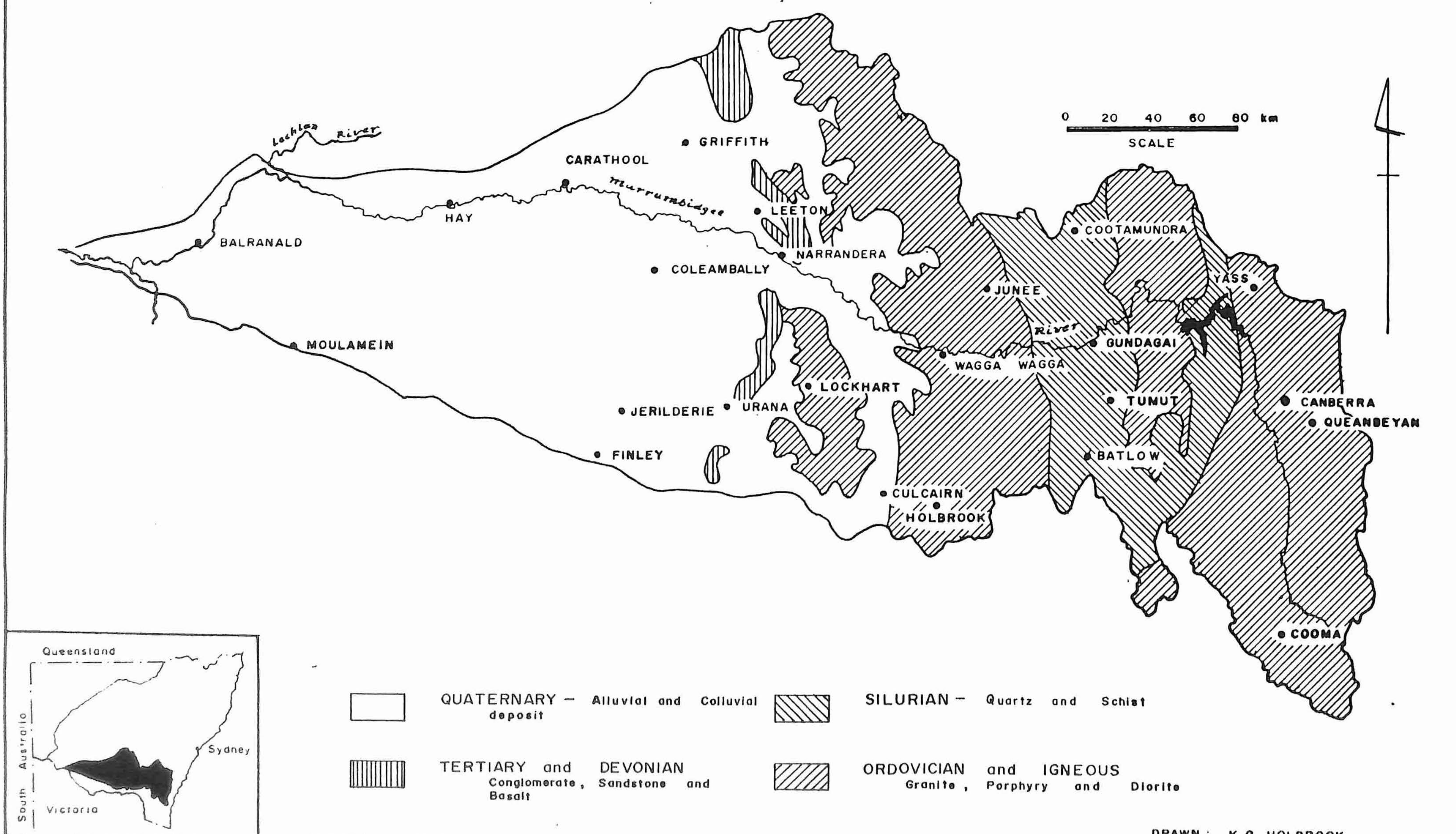
The impacts of induced dryland salinity can be assessed in both physical and economic terms. Appendix B is an economic assessment of dryland salinity.

The Murrumbidgee River Valley is dotted with saline discharge areas and it is reasonable to expect a continuing growth of the problem - both through recognition and actual saline development.


MURRUMBIDGEE RIVER VALLEY
FIGURE 2·2: ANNUAL MEDIAN RAINFALL
0 20 40 60 80 km
SCALE
380 mm
500 mm
630 mm
Lachlan River
Murrumbidgee
River
GRIFFITH
CARATHOOL
HAY
LEETON
BALRANALD
NARRANDERA
COLEAMBALLY
JUNEE
COOTAMUNDRA
YASS
MOULAMEIN
WAGGA WAGGA
GUNDAGAI
LOCKHART
JERILDERIE
URANA
TUMUT
CANBERRA
QUEANBEYAN
FINLEY
BATLOW
CULCAIRN
HOLBROOK
COOMA
380 mm
500 mm
630 mm
760 mm
1010 mm
1270 mm
1520 mm
1270 mm
1010 mm
760 mm
630 mm
500m
500m
630 mm
630mm
Queensland
South Australia
Victoria
Sydney
DRAWN: K.G. HOLBROOK

MURRUMBIDGEE RIVER VALLEY

FIGURE 2·3 : GEOLOGICAL FORMATIONS



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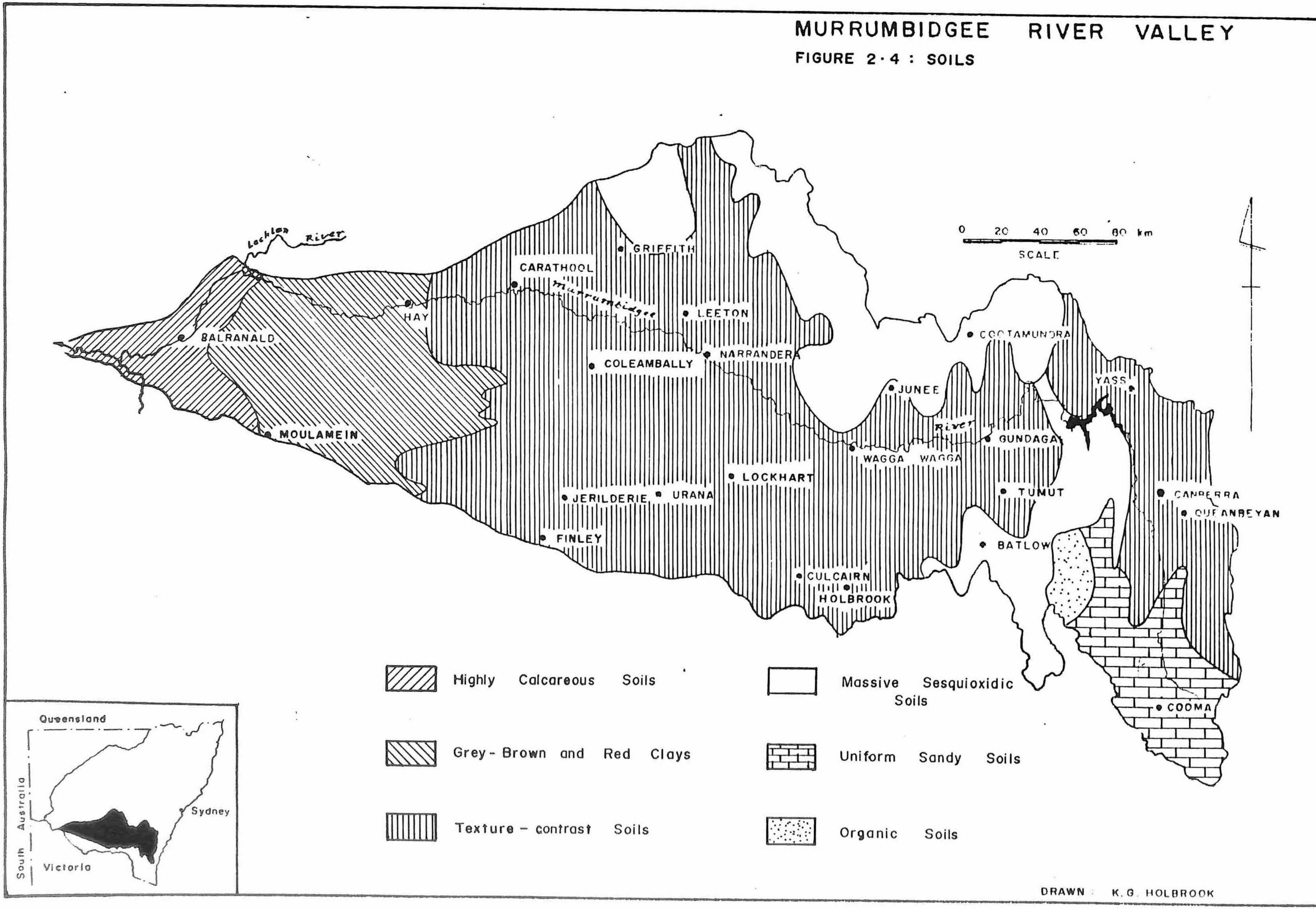

MURRUMBIDGEE RIVER VALLEY

FIGURE 2·4 : SOILS

3. Salinisation

The following section is a summary of the present understanding of dryland salinisation. It looks at the processes which are causing salinity, the control options available and the recommended approach to catchment management.

3.1 The Processes of Dryland Salting

The common occurrence of salinity across a wide range of environments is evidence of the common cause, a change in hydrological balance initiated by land-use changes which began with the clearing of native vegetation and the development of European agriculture. Dryland salinity is a result of the interaction of three basic ingredients. Firstly, a source of salt, secondly, the presence of water which is the transporting medium and finally, a hydraulic imbalance which will alter the distribution and movement of salts and water through the landscape.

Dryland salinity is a groundwater problem which is driven by recharge and groundwater movement as controlled by the various aquifer parameters. Despite the many mythical statements made about groundwater, it does behave according to certain physical principals. Basic in an understanding of groundwater is that the system will always move towards an equilibrium where the inputs (or recharge) will equal the throughflow which will equal the discharge. Consequently any change in the inputs or recharge of a groundwater system must in time be carried through to changes in groundwater throughflow and discharge.

The Murrumbidgee River Valley is an area of extensive agricultural land. Agrarian development dates back to the 1850's which has produced dramatic changes in the landscape. The pre-European Murrumbidgee was dominated by native forest, woodlands and native grasslands. Today we see most of the native vegetation giving way to pastures and cropping which have had a marked change in water use and deep infiltration to groundwater aquifers. The removal of a forest canopy will instantly increase rainfall on the ground by 15-20% (by the removal of interception) and where previously the continual use of available water by the relatively deep rooted natives ensured that only a very small percentage of the annual rainfall would percolate to the groundwater aquifers. European-agricultural practices (developed in a different environment) do not use as much of the available water and are allowing an increasing percentage of the annual rainfall to percolate to the groundwater system.

The result of increased recharge is a gradual rise in water-levels. Evidence of water-level rises is provided by regional groundwater monitoring undertaken by the Department of Water Resources at Cootamundra and Howlong. Cootamundra has experienced a mean water level rise of 3m over the past 72 years with a maximum increase of 27.4m. Howlong has experienced a mean water level rise of 12.4m with a maximum rise of 57.2m over a 59 year period. Many other studies have indicated the relationship between land clearing and watertable rise.

The rise in watertable, which is in effect an increase in throughflow, must transfer on to an increase in discharge. In some instances, deep rooted trees on the valley floors have acted as discharge areas. These are usually in low permeability aquifers, where the trees' uptake of moisture is greater than the rate of groundwater flow. Today many of these trees have gone and discharge sites are those areas where the watertable intersects the surface. Hence an increase in springs, seeps and soaks throughout the landscape. Watertables will continue on an upward trend until the system reaches an equilibrium where the recharge is equal to the discharge.

Salt is found stored throughout the landscape within the weathered profile. The origin of the salts is usually cyclic but held within the landscape due to the moderate rainfall and low recharge which was inadequate to flush salts through the system. The present hydraulic imbalance has mobilised many of these salts through increased groundwater flow. These are transferred to discharge areas where they are concentrated by the processes of evapotranspiration.

3.2 Management Options for Dryland Salinity

Management options can be divided into three broad categories:

1) Ignore it and do nothing.
2) Adapt farm management to help live with dryland salinity through saline agriculture.
3) Attempt to cure the problem by lowering watertables.

In reality, there are only two options as the long term cost of doing nothing is unacceptably high in terms of the loss of productive land and the contamination of waterways as well as general environmental degradation.

Saline agriculture requires the use of salt-tolerant plants to regain some level of productivity from salt-affected areas. This can be effective in minimising the loss of productivity through dryland salinity but does little to limit the spread of salinity nor the damage to the environment.

The control of salinity by lowering watertables may be possible either by mechanical means with the removal and disposal of groundwater, or through reduction of recharge by alternative land management. However lowering of watertables in dryland areas through mechanical means is seldom likely to be economic and is fraught with technical difficulties. The cost of tile drainage, the lack of pumpable aquifers, high salinity groundwater and the necessity for evaporative disposal are just some of the difficulties.

Another option for the lowering of watertables is the use of trees as biological pumps in the vicinity of discharge areas. This option has problems in that trees in discharge areas will fail if salt-concentrations or groundwater flow rates are too high for the trees to use. Their effect tends to be local and would do relatively little to prevent the further spread of salinity.

It would seem therefore, that the best options for salinity control are agronomic and on-farm methods of land management aimed at reducing recharge.

3.3 Catchment Management

To be successful in lowering watertables by reducing recharge, changes to the hydrologic balance must be effected as widely as possible throughout the groundwater catchment.

In the higher areas, establishment of trees on non-arable rocky areas and deep-rooted perennial pastures on the arable slopes, together with grazing management that favours evapotranspiration, is good policy for salinity control.

On the slopes and plains where cropping is prevalent, practices such as reduced fallow and the use of deep-rooted grain legumes such as lupins are options to increase water use.

The introduction of new species of crops and pastures better suited to poor soil conditions may increase water use and reduce groundwater recharge, particularly on the acidic soils of the upland recharge areas.

The degree of success with respect to alternative land management impacting on the problems of dryland salinity is largely dependant on the nature of the groundwater system. Local catchments will be easier to treat than regional systems and the time frame in which one might expect results will be far less. Nevertheless alternative land management in regional systems is equally desirable to either slow or halt the spread of dryland salinisation.

4. Dryland Salinity - Projects, Investigation and Research in the Murrumbidgee River Valley.

Following is a brief summary of the better known projects, investigations and research being undertaken on the subject of dryland salinity within the Murrumbidgee River Valley. This is not a comprehensive list but one based on the author's current awareness of other workers in the field.

1) Soil Conservation Service of NSW.

This organisation has been given the charter to control and manage dryland salinity as a land degradation problem. Consequently they are active in a number of areas ranging from extension to assessment, investigation and research.

a) Yass Valley Soil Conservation Project.

This is a major project covering an area of 122,500ha in the Yass River Catchment upstream of the Yass Water Supply Weir. The area is severely degraded by dryland salinity, as is much of the surrounding area.

The project aim is to study the dryland salinity problem and its associated hydrogeological parameters on a Total Catchment Management basis. Specific control and rehabilitation techniques are being implemented in a demonstration area established within the project.

The Soil Conservation Service of NSW is responsible for the development, co-ordination, planning, implementation, supervision and overall management of the project. The Department of Water Resources is carrying out the hydrogeological investigations, in combination with hydrogeologists at Sydney University and ANSTO (an arm of CSIRO). Their combined input helps in the implementation of control measures as well as broadening the understanding of dryland salinity processes.

Also within the Soil Conservation Service are a number of officers working in the field of dryland salinity. Their dedication to the salinity problem ranges from full time salinity related investigation to part time as in the case of District Soil Conservationists who must deal with salinity as it arises as an agricultural land degradation problem. A brief list and description of Soil Conservation activities is given below.

b) Dryland Salinity - Recharge Assessment - a three year NRMS funded project to aid Landcare groups in the identification of recharge areas. This project utilises electromagnetic-induction surveys as a tool in recharge assessment. This project is based in Wagga Wagga and services the Riverina Region.

c) Research Project - at the Wagga Wagga Research Service Centre - looking at the relationships between pastures, water use and recharge. There are two projects underway. The first is a pasture study involving pastures with contrasting water use characteristics, and a second project is aimed at developing native summer active pasture grasses for recharge control in the higher rainfall areas.

d) The establishment of piezometers (shallow bores) on some dryland salinity demonstration sites. These have been done by Soil Conservation in conjunction with Landcare groups. The aim is to collect information pertaining to the groundwater system and aid in the assessment of the dryland salinity processes in operation. They also serve as a monitoring system with which to measure the effect of alternative farm management aimed at reducing recharge and water-levels. These are on a relatively small scale and the two sites developed so far are at the farm management level, which does have some inherent problems in that dryland salinity needs to be tackled on a catchment basis.

e) Land degradation mapping is being undertaken for parts of the Murrumbidgee Valley. Most of the salt-affected areas should be covered within the next 12 months. The aim of this is to assess the extent of degradation and form a base from which remedial strategies can be implemented. The identification of salt-affected areas by air-photo interpretation has some problems. The continual development of new sites and the fact that the photos were flown in 1988 will inevitably lead to an underestimation of the extent of dryland salinity.

f) Trees on Farms - trials and advice on the establishment of trees to combat salinity. Advice is also provided on the re-vegetation and stabilisation of discharge sites as well as recharge area re-vegetation.

2) Landcare Groups.

Mention should be given to Landcare groups, many of which have been established on the basis of tackling the problem of dryland salinity and rising watertables. The ideal Landcare group adopts the problem as its own and then seeks a solution using available resources. That is, their own resources plus what aid and expertise is available to them through various other agencies, such as Soil Conservation, Water Resources, Department of Agriculture, Forestry, Greening Australia, Consultants and so on.

3) Department of Water Resources (DWR).

The DWR is responsible for the control and management of the state's water resources. Dryland salinity is also a water degradation issue, with the salinisation of aquifers and, perhaps more significantly, the salinisation of rivers and water-supplies. Hence DWR has been actively involved in addressing the dryland salinity problem.

A paper by Gates, Lawson and Williams outlines the aims of Water Resources Research in South East NSW.

- assist in the development of a salinity management strategy by defining the hydrogeological and hydrological processes.
- estimate recharge and its distribution on a regional scale.
- enable the effectiveness of various management options to be tested.

Within the Murrumbidgee River Valley, their research, both regional and site specific, has been in the Yass area.

4) Research Organisations.

a) CSIRO - Commonwealth Scientific and Industrial Research Organisation - is conducting research in two main areas. Firstly, in the field of electromagnetic induction techniques to aid recharge mapping. This work is located primarily in the Scenic Road Landcare Group near Young, but does at times spill over into the Murrumbidgee catchment. The other project is being undertaken by ANSTO (the nuclear arm of CSIRO) uses isotopes to study hydrogeochemistry in salt-affected areas within the Yass Valley Project.

b) Sydney University is also involved in the Yass Valley Project looking at hydrogeology and in particular the relationship between "lineaments" and the outbreak of surface salinity.

5) Others - Involved in Land-use Management.

a) Department of Agriculture - who principally research and provide advice on various agricultural management options.

b) Greening Australia - an organisation promoting the establishment of trees throughout Australia. The high environmental costs brought about by the clearing undertaken in the past 100 years has prompted a federal strategy of extensive re-establishment of trees.

c) Forestry - promoting and providing expertise in the field of forestry.

d) Consultants in Agriculture (pasture and cropping managmenent), Forestry, Hydrogeology and so on are also operating within the field of Dryland Salinity.

5. Discussion

A number of observations can be made regards dryland salinity. First of all, that it is a wide ranging problem affecting a variety of people. Those directly affected by the loss of land productivity and the degradation of water supplies, through to the indirect costs imposed on society who must pay for a less efficient agricultural sector and the construction of new water supplies to replace those which are becoming too saline to use. The general concept of environmental degradation is also important to a large proportion of society who no longer accept its unchecked advancement.

Dryland salinity is also a diverse problem in that it incorporates a number of disciplines. The groundwater hydrologists, soil scientists, agronomists, foresters, economists, ecologists, engineers, resource managers and others, all of whom have an important role in addressing the problem. Obviously, the most effective solutions will require the implementation of a strategy combining all available resources.

As has been outlined, a number of projects and investigations are underway regards dryland salinity. These can be divided into those looking at processes and those examining management options. Both groups have provided a lot of useful information in which basic strategies and current recommendations are based. They also point to shortfalls in our knowledge and future research requirements, highlighting the need for ongoing research to improve our understanding of the problem and to widen the options and/or their effectiveness as alternate management strategies to deal with salinity.

A potential problem is a lack of communication. Firstly between those studying processes, then with those developing alternate management strategies and finally to the people who are implementing these strategies.

The implementation of dryland salinity abatement strategies is perhaps the most important element in the whole problem. Research and investigation is vital to provide an understanding and develop management options, however "their worth is only as good as their use".

A question to be answered is "at what stage do we have enough information to begin effectively implementing salinity abatement strategies?" The general answer to this is: now!

The Soil Conservation Service is the principal organisation co-ordinating the extension of research and investigations to the community, as well as initiating many of their own research and investigation projects. Their aim is to achieve implementation by land-users through advice, assistance and demonstration.

Some of the problems not yet mentioned in addressing the dryland salinity problem with the Murrumbidgee River Valley are outlined below.

It is commented that there is a problem in applying the Yass Valley project and its demonstration sites to the Riverina region where land-values and productivity are different. The demonstration sites provide a package on dealing with salinity and rising watertables. The optimum strategy will vary according to land capability and productivity. What may be an acceptable management option on class V to VII grazing land in the Yass Valley would not necessarily be a viable option in the class III to V cropping and grazing lands which cover much of the Riverina's salt-affected areas.

There is a problem that land management options seem limited and there is a lack of information on the viability and effectiveness of alternative land management options. There would appear to be a need to establish demonstration sites where effective salinity management strategies are being implemented and these be monitored to show physical responses of soil and water as well as economic viability.

A further problem encountered when attempting to deal with the salinity problem is that effective solutions must look at the influencing catchment. The treatment of large regional catchments is a long term educational problem where management of large areas must be modified to reduce recharge.

The development, demonstration and extension of suitable alternative farm management options must be a high priority in addressing the insidious problem of dryland salinity and rising watertables.

Perhaps the most difficult part of the dryland salinity problem is determining the most effective way to implement our knowledge of dryland salinity and bring about a widespread change in land management practices.

Do we have enough resources?

- Bringing together a diverse range of information and successfully passing it on to the community is in essence what is required - how is this best achieved?

  - information co-ordination
  - extension/education
  - demonstration
  - assistance

  what priority do these components have?

6. Recommendations

The following recommendations are made based on the findings of this report.

1) This is a preliminary report undertaken in a minimum period of time. To be more meaningful, it needs to be further developed over the next 6 months.

2) Current levels of research and investigation need to be continued.

   There is a need for research into the question of deep percolation. The area between the soil/plant/air interface and the groundwater aquifer is not yet adequately understood.

3) The co-ordination and implementation of all available information is required for use in extension and demonstration of dryland salinity abatement strategies.

   - The demonstration of integrated farm management strategies which address dryland salinisation in conjunction with other related degradation issues is required.

- It would be appropriate to implement an integrated demonstration of property management at the catchment management level. Monitoring and investigation would be established with the potential to incorporate additional programs over time.

- The reclamation and management of saline discharge areas also needs to be demonstrated. In many areas the abatement of salinity by reducing catchment recharge is a very long term prospect and there is a present need to manage the discharge sites. These demonstrations require monitoring by piezometer to measure changes.

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ARID LAND SALINITY

Scalds are a common erosion feature of the textural contrast soils on the Riverine Plain in southern New South Wales. The grazing of the pastoral lands of western NSW during the first decade of settlement was marked by a lack of understanding of climate, rangeland characteristics and management requirements.

As a consequence, large areas were overstocked by sheep and suffered from rabbit plagues and inadequate stock watering systems.

The result was a widespread decline in pasture condition, particularly the cover of perennial species. With a lack of cover, the land was very susceptible to the ravages of wind and water erosion, leading to the extension of vast areas of scalded country. Much of this scalded, unproductive land was located on old terraces and raised floodplains of the western streams. Figure A1 is taken from a study of arid land scalding in the Riverine Plain.

Extensive natural re-vegetation of these scalds over the period 1950 to 1962 has been previously reported. Mapping of current scalds and areas that had re-vegetated between 1962 and 1980 has shown that this process is continuing.

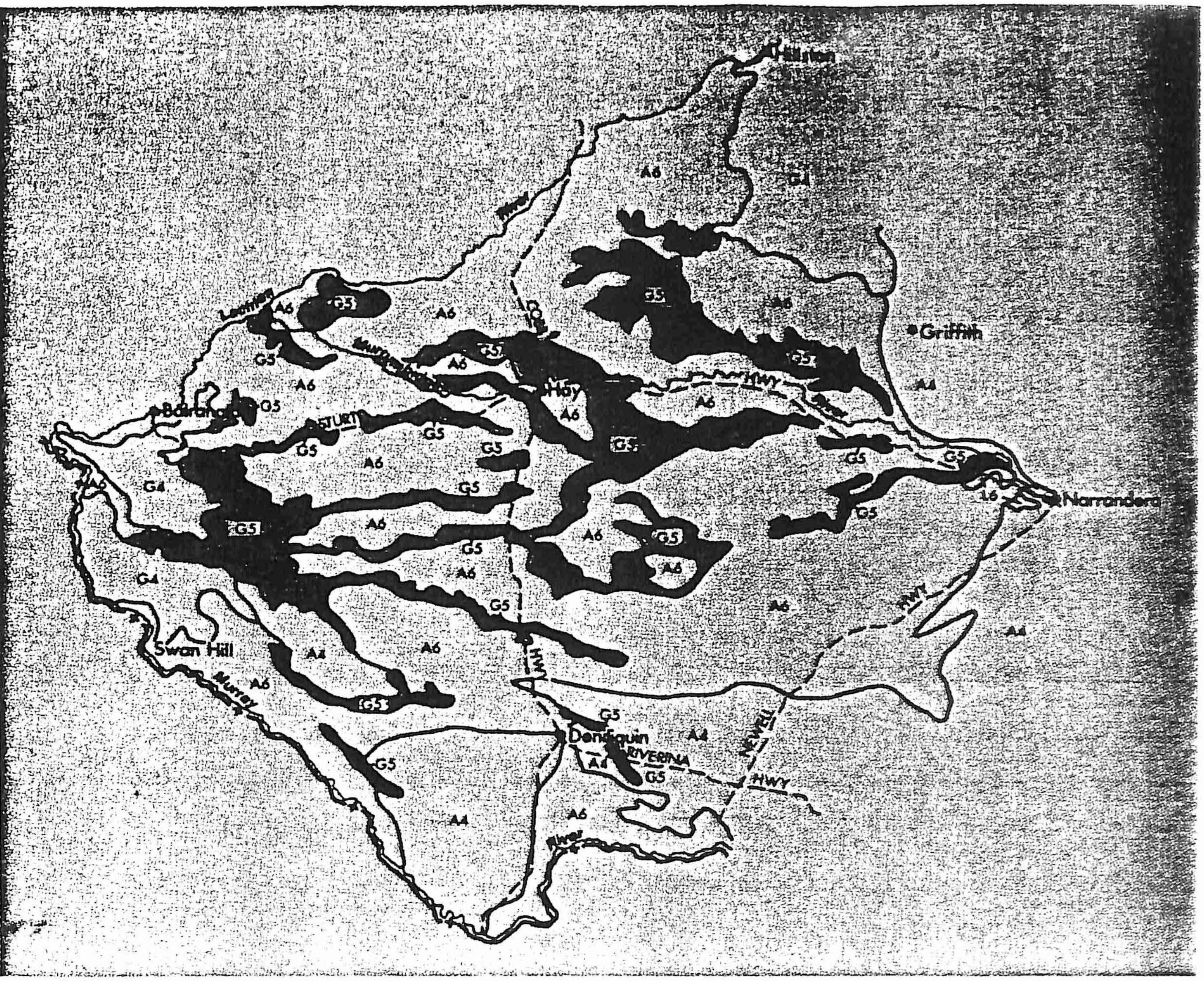

Figure A1 The study area and distribution of main soil types (after Atkinson and Melville, 1987).

Scale 1:2 000 000

A4 RED BROWN EARTHS — Moderately fertile texture contrast soils with hard setting topsoils prone to structural breakdown. Subsoils are dispersible and sodic, making them prone to water erosion and salinisation.

A6 COARSELY CRACKING GREY AND BROWN CLAYS — Deep moderately fertile alluvial heavy clays prone to compaction and salinisation under irrigated cultivation.

G4 CALCAREOUS EARTHS — Reddish brown gradational loams on dunes and sandplains. Swales contain brown uniform and gradational loams with nodular carbonate throughout the profile. Subject to severe wind erosion if disturbed.

G5 SCALDED RED TEXTURE CONTRAST SOILS — Severely sheet eroded alluvial texture contrast soils. Often associated with A6 soils.

L6 SILICEOUS DUNE SANDS — Deep uniform red sands. Low fertility and water holding capacity subject to severe wind erosion hazard if disturbed.

However, the rate of re-vegetation appears to be slowing down. Observations suggest that the remaining scalds are unlikely to re-vegetate naturally. It will be necessary to undertake artificial reclamation measures such as waterponding to further reduce the area affected by scalding.

Waterponding has been successfully used to reclaim textural contrast soils which have been eroded by wind and water erosion.

Scald reclamation aims to establish perennial species which will enable a permanent long term increase in sustainable grazing rate.

Initially re-vegetation is aided by waterponding because run-off is reduced and subsoil moisture increased. In the longer term, leaching causes collapse of the sodic B-horizon which forms shrinkage cracks on drying. These improve infiltration. The subsequent improvement of soil structure encourages continued re-vegetation.

APPENDIX B

THE ECONOMIC IMPACT OF INDUCED DRYLAND SALINITY
A FRAMEWORK FOR ASSESSMENT

Induced dryland salinity makes productive farmland unproductive with consequent economic penalties. The economic costs of salinity can be determined from a knowledge of the nature and extent of the problem and the means and costs of overcoming it. As this body of information on salinity grows, there is an awareness that it is a significant economic problem. The more so because it has developed over a long period and will take a long term effort to correct. This leads to the need to allocate resources to the problem with the aim of achieving a nett economic benefit. In view of this, a number of specific hydrogeological and agronomic facts need to be established. These provide the framework for determining the economic impact of salinity and the cost benefit studies necessary to allocate corrective resources.

Degree of Economic Damage to Salted Areas

The damage to crop and pasture production caused by salt is a continuum ranging from slight damage, ameliorated by tolerant species, to total production loss. The economic effects of this agronomic damage are generally assessable, particularly in the extreme cases and are expressed normally as a percentage loss of production. This assessment, coupled to average production value, can determine the income effect on production of salinity per hectare. A secondary effect of this is the capitalized effect of lost production reflected in the value of the land. Until recently, stable historical saline sites have had little impact on land values. This situation is changing as awareness of the potential spread of salinity and its economic damage are factored into land values. The evidence of this is anecdotal to date.

Extent of Economic Damage

The extent or area covered by induced dryland salinity affects the economic aggregates simply by multiplying it by the degree of economic damage. The figures available on the areas affected by salinity have increased rapidly and have shown a considerable change over the past decade. In 1982 a report on 'Salting on Non Irrigated Land in Australia' by the Working Party on Dryland Salinity in Australia estimated that there were 4,000HA affected by 'seepage salting' with land value and production costs of $2.4m and restorative costs of $.5m (1982 dollars). Furthermore the report added that 'In the tentative opinion of the responsible officers of the NSW Soil Conservation Service, on the basis of numerous observations and detailed experimentation, increases in the size of individual (saline) areas and the number of outbreaks are unlikely to occur.'

In 1988 the Land Degradation Survey carried out by SCS of NSW found that 14,000HA were moderately or severely affected by saline seepage with capital land value lost being $22m and annual gross value of production lost being $2m. In constant value dollars this represents more than a threefold increase in lost wealth and income since 1982 due to salinity.

Current detailed investigations in the Murray Darling Basin to identify land degradation show substantial additional areas of salinity. Significantly most of these show salinity in its early stages.

From an economist's standpoint, this data establishes that the area affected by salinity in NSW is in excess of 14,000HA and is probably considerably higher.

Rate of Increase in Salinity

From 1982 data, 1988 data and current investigation, it is clear that the area affected by salinity is increasing significantly. One difficulty with this assessment is that some of the increased area identified is due to better evaluation of existing salinity rather than increased areas affected by salinity. One SCS estimate (Keith Emery) suggests that the rate of increase of salinity is in the order of 10-15% pa. Even taking the lower estimate of 10%, this would lead to a doubling of the area affected by salinity roughly every seven years. If this rate of increase were to be maintained for fifty years, it would involve 1.8 million hectares being affected by salinity.

Onsite and Offsite Costs

The degree of lost production, the area affected by salinity and the rate of change of the area affected relate to costs due to lost agricultural production on the farm. The costs extend beyond this. The offsite or downstream effects on water quality and irrigation production, have been evaluated. Powell and Jensen suggest that a fourfold multiplier should be used - that is for each dollar of production loss on farm, four dollars costs are incurred in relation to water quality and irrigation production loss. The offsite multiplier cost would have to be investigated and determined for each catchment to allow accurate economic analysis.

Costs of Overcoming the Problem

The incidence and impact of salinity are frequently separated with the costs of solving the problem lying with landholders who do not suffer the problem. Futhermore, the considerable offsite costs due to degraded water supplies are frequently not able to be met by the landholders at the source of the salt discharge.

The situation suggests a failure of normal market mechanisms to cope with the problem. In acknowledgement of this, government intervention has been deemed necessary. In this circumstance, without the economic discipline of market forces, careful cost benefit analysis should precede any commitment of resources.

The cost of many government sponsored solutions to salinity have been high and the results long term and sometimes uncertain. Accordingly it is important from an economic standpoint that solution to salinity should be in themselves economically sustainable, such as agroforestry and deep-rooted pastures on recharge areas.

Some Reflections

The Cost of Doing Nothing. From the estimates of the area affected by salinity, its capital and recurrent costs and the estimated rate of increase in area affected, the costs of doing nothing are very high, with estimated annual production bases in the order of half a billion dollars (in 1989 dollars) by 2050 in NSW alone, and doubling every 7 years thereafter.

This estimate can be challenged as it is based on what could be described as tenuous data. Evidence so far has shown however that we have tended to underestimate the economic effects of salinity.

Waiting for Accurate and Well Researched Data The areas of economic concern that I have touched on are all currently under investigation and research. There is no evidence that this research will indicate that the problem will be solved without intervention (as was hoped in 1982). It appears economically unsound to delay remedial action on a 10% compounding problem that has a long lead time for remedy. Current data provides sufficient information to provide informed cost benefit analyses on many saline areas.

Conclusion

Combatting salinity is an inexact art; so is economics. An economic analysis of salinity is thus open to criticism on the basis of the number of questionable judgements that have to be made. This aside, the intent, severity and rate of increase in salinity provide a broad framework for assessing the costs of the problem. Providing the solutions are in themselves economically sound (i.e. self-funding) then a favourable cost benefit analysis can be expected. The failure of the market focus to solve salinity problems makes non market intervention necessary.

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