LAND

Land Use

Trends

- Residential land use: **INCREASING** in peri-urban regions with resulting pressures on biodiversity, water resources and agricultural land.
- Change from relatively low intensity land use (such as grazing) to higher intensity uses (such as viticulture and plantation forestry): **INCREASING** in some regions.
- Use of chemicals with residual impacts **DECREASING**.
- Awareness and knowledge of site contamination: **INCREASING**.

Goals

Prosperous communities and industries using and managing natural resources within ecologically sustainable limits.

Goal 2, State Natural Resources Management Plan 2006

Land use and a sustainable South Australia

Land uses have major implications for South Australia's natural resources including its soil, water, plants and animals.

Intensification of land uses away from relatively low intensity agriculture such as grazing, towards more intensive uses such as viticulture, horticulture and residential development, places greater pressure on water resources, highly productive agricultural land and biodiversity. Many of the most invasive weed species are derived from agricultural, pastoral, garden and forestry systems and their ranges are often associated with these production systems (Adelaide and Mount Lofty Ranges Natural Resources Management Board, 2008).

If a particular land use is not compatible with the nature of the land – its soils, water and vegetation – and if ongoing management does not take into consideration the interaction of these factors in the long term, significant environmental, social and economic problems can occur. Crop selection and farm management practices for example, play a key role in processes affecting catchment salinity and water quality, as well as rates of soil erosion, acidification, nutrient decline and carbon loss.

Problems can also occur if new land uses are not compatible with past land

Plant Remediation of Contaminated Land

The use of vegetation to help rehabilitate altered landscapes has been used in many situations including to:

- help reduce watertable height and therefore, salt damage
- increase species variation including by supplying food and shelter, to increase the indigenous biodiversity
- modify soil chemistry such as through legumes cycling of nitrogen
- purify water, e.g. in wetlands

However, the use of Metallophytes (plants evolved to survive on metal-rich soil), has largely been ignored as a means of rehabilitating contaminated lands such as post-mining sites.

Metallophytes have the ability to draw metal contaminants from the soil. These contaminants can then be harvested from the plants, thus removing them from the area.

This process has the potential to aid the remediation process following mine closures, shortening the time required to return the site to near its pre mined state sooner.

Source:

Whiting, S.N., Reeves, R.D., Richards, D., Johnson, M.S., Cooke, J.A., Malaisse, F., Paton, A., Smith, J.A.C., Angle, J.S., Chaney, R.L., Ginocchio, R., Jaffre, T., Johns, R., McIntyre, T., Purvis, O.W., Salt, D.E., Schat, H., Zhao, F.J., and Baker, A.J.M. (2004). Research Priorities for Conservation of Metallophyte Biodiversity and their Potential for Restoration and Site Remediation. Restoration Ecology. Vol. 12, no. 1, pp 106 – 116.

Vineyards, Barossa Valley

uses. Building houses on unremediated land that was once used for industrial purposes, such as a foundry or tannery for example can have health implications for occupants in cases where the previous use has resulted in soil contamination or pollution. The use of pesticides can also cause site contamination on a broader, more diffuse scale. South Australia's low level of pesticide application by world standards means that this is less likely to be a significant problem in South Australia.

Land use information is used in Australia to manage catchment salinity, nutrient and sediment problems, measure greenhouse gas emissions and sinks, and to assess agricultural productivity. This information can be used in evaluation of crop alternatives and land value determinations, in local and regional planning, pest and disease control and emergency response planning. The Department of Water, Land and Biodiversity Conservation (DWLBC) has undertaken extensive land use mapping of South Australia's regional areas.

Indicators

CONDITION INDICATOR

- **Current land use in South Australia**

This provides an indication of current land uses and a baseline against which to assess change over time

PRESSURE INDICATORS

- **Land use change in South Australia**

Land use change is a direct measure of potential pressure on the environment

- **Awareness and acknowledgement of site contamination**

Awareness and acknowledgment of site contamination reduces ecological and human health impacts associated with soil and groundwater contamination

Cattle farm

'It is important to recognise conservation of natural environments as a legitimate land use.'

What is the current situation?

CONDITION INDICATOR: Current land use in South Australia

The *State of the Environment Report 1998* indicated that information on land use was either very old or incomplete, making it difficult to identify trends.

Information presented for the first time in the *State of the Environment Report 2003* was of much better quality and in 2008 we are now able to present some trend information. The data has been sourced from the Land Use and Management Mapping of South Australia Program conducted by the DWLBC.

The major land uses in this state are livestock grazing on native species, conservation, natural environments and dryland agriculture, which includes the growing of crops and the grazing of livestock on modified pastures (Table 4.1).

What are the pressures?

Conservation and natural environments

Of the land that has been mapped, conservation and natural environments cover 39.2% or 38,511,184 Ha of the state. This represents a 4.4% or 1,789,617 Ha decrease from the figure reported in the State of the Environment Report 2003.

However, the 2003 report included Lake Eyre, Lake Torrens and Lake Gairdner as National Parks. Following more detailed mapping of the state's far north and a review of methodology, these areas are now included in the statistical Water classification. The majority of the conservation and natural environments land use occurs in the far north.

This broad land use category is subject to a relatively low level of human impact. Specific land uses include National Parks and Wildlife Reserves, Aboriginal lands, protected landscapes and defence and nature reserves. National Parks and Wildlife Reserves occupy around 49% of the land within this category.

It is important to recognise conservation of natural environments as a legitimate land use. Other land uses can impinge on the effectiveness of conservation reserves to maintain ecological processes and conserve biodiversity. In particular, conservation areas can be affected by pressure from weeds, feral animals and farm chemicals, because they are adjacent to agricultural and residential land uses.

The potential impact of other land uses on conservation areas is lowest in the far north, where such areas tend to be large and other land uses are of relatively low intensity (see following section). Conversely, it should be recognised that some under-resourced conservation areas have weed impacts on neighbouring productive land.

Production from relatively natural environments

This broad land use category occupies the largest proportion of South Australia at around 43.6% or 42,828,863 Ha, a decrease of 2% or 863,103 ha of mapped land from figures reported in 2003. Land in this category is generally subject to relatively low levels of human impact.

The major land use is grazing on native species in the Rangelands region. Sheep grazing dominates south of the dingo fence and cattle grazing north of it.

Over-stocking and grazing by rabbits in the past has led to the degradation of vegetation and soil erosion in many regions. The introduction of rabbit haemorrhagic disease (*calicivirus*) led to the successful germination of native species such as Mulga (*Acacia aneura*) for the first time in one hundred years. The decreasing effectiveness of the

Table 4.1: Land use in South Australia, 2008

Primary Description	Area (ha)	% of the State
Conservation and Natural Environments	38,511,184	39.2
Production from Relatively Natural Environments	42,828,863	43.6
Production from Dryland Agriculture and Plantations	10,728,136	10.9
Production from Irrigated Agriculture and Plantations	264,461	0.3
Intensive Uses (including Human Settlement)	1,633,737	1.7
Water	4,207,673	4.3
Unmapped Areas	3,520	0.004

Source: DWLBC

disease is now apparent with increasing evidence of resistance. Recovery of flora is slow in some areas despite de stocking, due to a series of poor seasons and the vulnerability of some species to even low stocking levels.

A detailed lease assessment program established in 1989 under the *Pastoral Land Management and Conservation Act 1989* requires regular assessments of land condition (including native vegetation) and estimates of its ability to support stock. This has helped to improve land management in the region over the last decade or so.

Production from dryland agriculture and plantations

Since the 2003 report, this broad land use has increased 7.2% or 722,770 Ha and now occupies around 10.9% or 10,728,136 Ha of the state. This is based on dryland farming systems where the majority of native vegetation has been cleared.

Typical land uses include stock grazing, cropping, plantation forestry and a wide range of horticultural production. In 2005 South Australia produced 24.6% of the gross value of Australia's barley crop and 12.3% of the gross value of the nation's wheat (ABS, 2007a).

Agricultural land uses have significantly changed the landscape. However, land and crop management practices are improving in many regions as a consequence of new agricultural and communication technologies and a growing awareness of the benefits of changing traditional farming practices. Soil loss associated with agricultural land use in South Australia, for example, has reduced considerably over the past 50 years and continues to decline as a direct result of better land management practices.

Forestry plantations occupy around 174,018 hectares of land in South Australia. The majority of this is in the so-called Green Triangle around Mount Gambier. The majority of the remainder is found in the Mount Lofty Ranges and the state's mid north. Most of these forestry plantations consist of softwood, predominantly *Pinus radiata*, although there is an increasing trend towards the establishment of hardwood plantations, particularly *Eucalyptus* species. This reflects developing market opportunities for short rotation hardwood timber crops that lead to higher economic returns (Hamblin, 2001). Forestry SA also manages 24,000 Ha of native forest reserves. These have multiple-use objectives including recreation and conservation.

There are concerns that growth of the forestry industry, particularly in the lower South East, Mount Lofty Ranges and the Middle River catchment on Kangaroo Island, may have a potentially negative impact on regional water resources and biodiversity. Carbon offset schemes, such as the proposed *Carbon Pollution Reduction Scheme*, are likely to accelerate the establishment of additional forests as carbon sinks (forests planted for the purpose of permanently storing carbon). Good land use planning will be required to avoid any adverse environmental impacts from the introduction of this scheme.(Department of Climate Change, 2008).

Irrigated agriculture and horticulture

This land use occupies around 0.3% or 264,461 ha of South Australia, an increase of 19% or 42,154 Ha from the 2003 figures and consists of irrigated horticulture, viticulture and pastures.

These activities can place greater pressures on the environment than less intensive agricultural uses such as cropping and grazing. In particular, irrigated crops can place greater pressures on surface and groundwater resources due to higher water demand.

The drainage of irrigation water from the dairy pastures along the lower River Murray between Mannum and Wellington, has been cause for concern over a number of years, particularly in terms of the implications for the river's water quality. Monitoring by the Environment Protection Authority (EPA) indicates levels of faecal bacteria exceed national guidelines for drinking water and recreational use at Tailem Bend, due largely to pollution from irrigated dairy pastures.

A major program to rehabilitate 4,000 hectares of lower Murray dairy pastures was announced by the state government in 2003 and will be completed by December 2008. The Lower Murray Reclaimed Irrigation Area Restructuring and Rehabilitation Program seeks to significantly reduce the pollutant load returned to the river through:

- electronic water metering and rehabilitation of all intakes from the river to improve water efficiency

Cropping, Pt Turton. Photo: Monica Moss

‘Land use change from agricultural to residential are particularly marked in the northern and Fleurieu sections of the Adelaide and Mount Lofty Ranges region.’

Olive grove. Photo: Steven Mudge

- implementation of runoff reuse systems on all farms to eliminate surface irrigation runoff to the river and to retain the polluted primary flush of the first 5 ML per 100 Ha of irrigated area of stormwater runoff
- fencing channels and levee banks to prevent stock access
- regrading of cattle laneways to reduce runoff to drainage channels
- management improvements to further reduce pollutant discharges through individual on-farm Environmental Improvement Management Plans including better timing for fertiliser applications
- purchasing water entitlements from dairy farmers
- purchasing of land from dairy farmers and taking it out of production.

The increasing establishment of vines across South Australia was identified in previous *State of the Environment Reports* as being largely driven by a buoyant wine industry. South Australia produced 44.4% of the gross value of Australia’s vine production in 2005 (ABS, 2007a). This equated to 74,620 Ha, an increase of 12.3% since 2003 (www.phylloxera.com.au).

Intensive uses

Intensive land uses occupy 1.7% of South Australian land, an increase of 21.4% over 2003 figures. These uses involve high levels of interference with the natural environment and are generally associated with human settlement. They include urban and rural residential development, mining, transport and communication, manufacturing and waste treatment and disposal.

South Australia is a highly urbanised state, with 73% of the population living in Adelaide (ABS, 2007b). By comparison, only 45% of Queenslanders live in Brisbane because of the more regionalised nature of settlement in that state.

The Adelaide metropolitan area continues to spread into the Mount Lofty Ranges.

This expansion is generally but not always, into areas that were previously used for grazing, cropping or horticulture. Adverse effects from the changes include the loss of biodiversity, diminished water quality and loss of prime agricultural land.

Residential living is also increasing significantly along the South Australian coastline as a greater number of people seek a more relaxing lifestyle in closer proximity to a beach (refer to chapter ***Coastal and Marine Resources*** and ***Urban Form and Population*** for further information).

Mining occupies only a very small proportion of South Australia. Major products include copper, gold, iron, gypsum, granite, oil, gas, coal, uranium and opals. Of these non-renewable resources, copper has the highest value of any mined commodity in South Australia at $1.36 billion in 2005 06, (ABS, 2007c).

The impact of mining on the environment has been significantly reduced in recent years (Hamblin, 2001). Nevertheless, the expected substantial growth in the mining sector could have significant negative environmental implications in terms of water use, infrastructure costs, biodiversity, increased demand on the state’s energy supplies and pressure on emissions reduction targets unless well managed (see also the ***Native Vegetation*** *and* ***Energy*** chapters).

PRESSURE INDICATOR: Land use change in South Australia

Broad land use categories across the state tend to remain relatively stable. However, distinctive trends and small-scale changes are evident in some regions and for some particular types of land use.

The current trend away from relatively low intensity agricultural land uses such as grazing, towards more intensive ones such as viticulture, horticulture and residential development, means that there are now greater pressures being placed on the environment in some regions. This is increasing pressure on water resources, highly productive agricultural land and native vegetation in those regions.

Land use change in South Australia that has associated issues for which there is data available include:

- increasing residential development in the Mount Lofty Ranges
- the increase in area planted to grape vines
- impact of plantation forest land use on water yield from catchments
- an increase in coastal development.

Increasing residential development in the Mount Lofty Ranges

Previous South Australian State of the Environment Reports in 1993, 1998 and 2003, have highlighted the expansion of Adelaide into the Mount Lofty Ranges as a major pressure on rural and semi-rural land uses in the region. This issue continues to cause concern in 2008.

Analysis of land use in the region in 1993 and 2003 shows that during this period there was a 128.3% increase in rural residential living from 9,029 Ha in 1993 to 20,565 Ha in 2003. During that time there was an 8.4% decline in the area occupied by dryland and irrigated cropping.

The EPA has expressed concern about the environmental impact of increasing housing developments in the Mount Lofty Ranges, particularly in the Mount Lofty Ranges Watershed.

The EPA's Watershed Protection Office has previously estimated that if all vacant allotments in the Mount Lofty Ranges were developed there would be a 25% increase in the number of houses in this environmentally sensitive region. There are concerns that insensitive housing developments will lead to the further loss and fragmentation of native vegetation, exacerbation of bushfire risks to housing and human life, and increasing degradation of water quality.

A development risk assessment study conducted by the EPA in early 2003 centred on the Crafers, Stirling, Aldgate and Bridgewater area found that 22% of the 350 vacant allotments inspected should not be developed for housing due to significant site constraints. These included land close to watercourses, covered in native vegetation and prone to flooding and/or water logging.

The Adelaide and Mount Lofty Ranges Natural Resources Management Board's State of the Region Report identifies pressures associated with urban development at the northern and southern edges of metropolitan Adelaide and on the Fleurieu Peninsula, as well as intensification of agriculture (Adelaide and Mount Lofty Ranges Natural Resources Management Board, 2008).

Land use change from agricultural to residential are particularly marked in the northern and Fleurieu sections of the Adelaide and Mount Lofty Ranges region. Based on current data regarding the number of land titles outside the urban and township boundaries, there is potential for a further 40% increase on 2005 dwelling numbers effectively doubling 1985 levels.

Increases in residential and rural residential uses and increases in more intense land uses such as horticulture (compared to grazing) have the potential to create additional land use interface issues and apply pressure to prime agricultural and horticultural land (Adelaide and Mount Lofty Ranges Natural Resources Management Board, 2008).

Similar encroachment is occurring around regional towns in the upper Yorke Peninsula, Riverland, and Mt Gambier, that may adversely impact on land and infrastructure that is important for current and future agricultural activity. Currently, Development Plans do not differentiate rural areas on the basis of their importance for primary industry and market forces do not reflect the true cost of loss of productive agricultural land.

The region has significant advantages and opportunities for some agricultural enterprises including some access to reclaimed water, proximity to labour, markets and freight facilities and for some horticultural crops, favourable climatic and soil conditions not found elsewhere in South Australia. The further loss of these areas to residential development potentially represents the loss of a valuable resource to the state.

Irrigated agriculture and plantations

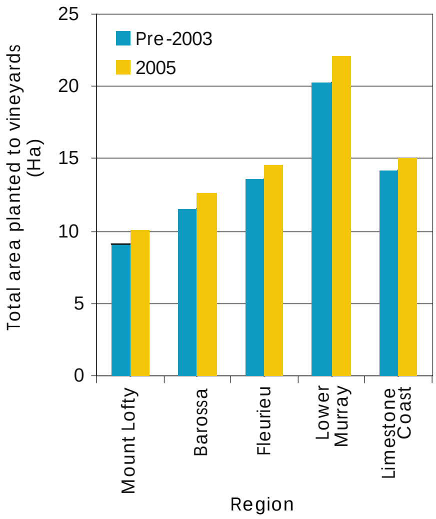
One of the most significant changes in land use over the past decade has been an increase in the area occupied by vineyards; often with an associated loss of grazing or cropping land. In the Riverland region vines are replacing citrus and stonefruit crops.

The total area of vineyards in South Australia increased by 150% between 1994 and 2002, from 26,584 Ha to 66,456 Ha, and by a further 12.1%, to 74,620 Ha between 2002 and 2005 **(www.phylloxera.com.au).**

Figure 4.1 shows the total area planted to vineyards in the state's major established grape growing districts before 2003 and in 2005. All areas have shown growth. The Mount Lofty Ranges has shown the highest rate of growth, with an increase of 10.4% in the area planted since 2003.

Where viticulture is replacing dryland farming activities, this development

Figure 4.1: Total area planted to vineyards



Source: DWLBC

Pine plantation, Flagstaff Hill.
Photo: Steven Mudge

may place strong demands on water in areas that are already developed to their sustainable limit. These include areas of the Mount Lofty Ranges and the Clare and Barossa Valleys. The further development of crops requiring irrigation will likely require investment in other water sources such as reclaimed water, as most existing accessible water resources are fully prescribed and being managed within sustainable limits under the *NRM Act (2004)*.

Production from dryland agriculture, horticulture and plantations

Plantation forestry can have a significant impact on regional water resources and biodiversity. Plantation forests can impact on catchment hydrology by reducing recharge, intercepting surface water flows and, where watertables are shallow, directly intercepting groundwater. Consequently a change of land use to plantation forest can reduce available water resources and place pressure on water dependent ecosystems.

In addition to the potential environmental consequences in areas where the available water resources are approaching their allocation limit or are already fully allocated, any reduction in the availability of water resources may impact on existing users of that resource. This situation potentially exists in a number of regions notably the South East, Mount Lofty Ranges and Middle River catchment on Kangaroo Island.

An increase in forestry in some locations in the Mount Lofty Ranges may also affect some threatened species and ecological communities, in particular the Swamps of the Fleurieu Peninsula, the Mount Lofty Ranges Southern Emu Wren and the plant species *Euphrasia collina ssp. osbornii* (Osborn's Eyebright) and *Prasophyllum frenchii* (Maroon Leek Orchid).

PRESSURE INDICATOR: Awareness and acknowledgment of site contamination

In November 2007, the South Australia Parliament passed the *Environment Protection (Site Contamination) Amendment Act 2007*. This legislation was more than 10 years in the making and assigns responsibility for site contamination, establishes a statutory audit system and gives the EPA power to retrospectively deal with site contamination. There are various clauses that are already operating with the balance planned for commencement in the period leading up to February 2009.

Site contamination may result from the introduction of chemical substances to a site. However in South Australia, the existence of chemical substances is only one aspect of site contamination. *The Environment Protection Act* (1993) now states that to be considered contaminated the consequence of the introduction of chemical substances must not be trivial and must pose a risk to human health and/or the environment, taking into account current or proposed land uses. However, for waters (including groundwater) the introduction of a chemical substance is deemed as site contamination when there is harm that is not trivial.

The *Environment Protection Act (1993)* provides for a risk based approach to remediation. By way of definition, to remediate a site means treat, contain, remove or manage chemical substances on or below the surface of the site so as to:

(a) *eliminate or prevent actual or potential harm to the health or safety of human beings that is not trivial, taking into account current or proposed land uses; and*

(b) *eliminate or prevent, as far as reasonably practicable—*

  (i) *actual or potential harm to water that is not trivial; and*

  (ii) *any other actual or potential environmental harm that is not trivial, taking into account current or proposed land uses.*

Uniquely, the Act allows a person or persons, to transfer their liability for site contamination.

There are several matters that need to be finalised before all of the site contamination provisions commence, including:

- finalisation of the regulations
- changes to the *Development Act* and *Land & Business (Sales & Conveyancing) Act*
- development of an audit system and accreditation of auditors
- development of internal business systems to manage new information associated with the legislation
- review of existing files
- development of a suite of publications to assist stakeholders

- development and delivery of education programs for stake-holders.

The National Environment Protection (Assessment of Site Contamination) Measure (1999) is being reviewed at this time and the South Australian EPA is a contributor.

Contamination is also recognised as being an issue of urban consolidation due to the transformation of older, inner-city sites into residential areas. These sites were typically contaminated by previous industrial uses such as foundries and tanneries.

Sensitive land under the *Environment Protection Act* (1993) now includes residential, child-care centres, pre-schools and primary schools. It is intended that the Development Act will be amended so that if a sensitive land use is proposed for a site where there has been a contaminating activity, a site audit will be mandatory.

The number of sites affected by contamination in South Australia is largely unknown. However, since publication of the *State of the Environment Report 1998,* there have been significant advances in our knowledge and understanding of site contamination. A number of national and state initiatives have influenced the manner in which the EPA records and reports on issues associated with the contamination of land and groundwater.

The types of activities that can lead to site contamination include industrial and commercial land uses; the disposal or accidental spillage of waste and chemical substances; leakage during plant operation, storage or transportation; the spreading of sewage sludge; and the use of pesticides. Examples of specific activities that can cause site contamination include:

- gasworks
- battery manufacture, storage and recycling
- dry cleaning
- oil production, treatment and storage
- foundries
- railway yards
- service stations
- smelting and refining
- tanning and associated trades
- scrap yards
- fertiliser manufacturing plants
- power stations.

The EPA is prioritising known sites according to risk and will take action on a risk basis to effectively manage site contamination across the state.

In addition, the EPA has commenced development of an *Underground Storage System Code of Practice* to manage high risk activities. The relevant industry sectors will be the focus of the EPA strategic (site contamination) education campaign intended for late 2008.

Pesticide use

Pesticides collectively include chemicals commonly referred to as insecticides, herbicides, fungicides and growth promotants.

The use of pesticides has improved crop yields, increased world food security, and assisted with the control of disease globally. These benefits are not without risks. Pesticides by nature have the capacity to negatively impact the environment if used incorrectly and in some cases, have the potential to adversely impact human health.

Both animals and humans can be affected by eating food contaminated by pesticides, drinking contaminated water, breathing in contaminants or absorbing contaminants through the skin. The public's perception of these risks in association with higher general environmental awareness in recent years, have seen greater local interest in organic foods and other products (Rural Industries Research and Development Corporation, 2006). There is also a greater awareness in food supply industries of the increasingly competitive and lucrative market for environmentally friendly and sustainable produce that is clean and green.

Due to the method of their application, pesticides have the potential to cause widespread contamination of soil and water at a diffuse level. Broad spectrum chemicals and those with any long term residual effects have been progressively eliminated from agricultural systems, however chemicals of this nature remain in soils where they have been used for spot and broadacre pest control (DAFF, 2005).

The accumulation of herbicide residues in soil may impact native vegetation and crops, enhance weed resistance, affect

Market gardening within metropolitan Adelaide region. Photo: Steven Mudge

Crop. Pt Turton. Photo: Monica Moss.

soil microorganisms and nitrogen fixation, increase the incidence and severity of root diseases and interfere with the uptake of nutrients by plants.

The Commonwealth Department of Agriculture, Fisheries and Forestry through a number of programs manages the presence of these residues and their impact on foods at a national level. These programs include the National Hormonal Growth Promotant (HGP) Program, the National Antibacterial Residue Minimisation (NARM) Program and the National Organochlorine Residue Management (NORM) Program. As well as registering sites across Australia that are known to be contaminated, the programs manage and restrict access of livestock to them. Farmers now use so-called soft chemicals that are active on the specifically targeted species only at or immediately after, the time of application.

Australia's and South Australia's very low levels of pesticide usage are reflected in the levels of pesticides detected in food samples. The National Residue Survey coordinates annual monitoring of chemical residues, consistently demonstrating that they are only detected at very low levels in the Australian diet. The 2003 SoE Report showed that of 274,000 food analyses done in the National Residue Survey during 2000–01, there was 99.97% compliance in grain and horticulture, 99.98% in meat and 100% in fish samples in terms of any pesticides detected being below allowable Maximum Residue Limits (AATSE, 2002). In the 2006-07 National Residue Survey the results were similarly compliant, with 99.64% compliance in grain, 98.74% in horticulture, 99.81% in meat and 99.03% in fish samples (DAFF, 2008).

There is a lack of comprehensive data on pesticide use in South Australia and the level of contamination of water and soil resources through pesticide application is unknown.

What are we doing about it?

The Development Act 1993, Development Regulations 1993, *Planning Strategy and Council Development Plans* provide the legal and strategic framework that controls land use across the state.

The four volumes of the *Planning Strategy – Planning Strategy for Regional South Australia, Planning Strategy for Metropolitan Adelaide, Planning Strategy for the Outer Metropolitan Adelaide Region and Yorke Peninsula Regional Land Use Framework* – were updated in December 2007. These documents acknowledge the importance of integrating natural resource management with land use planning and the consideration of land capability in the planning and assessment process. The strategy aims to improve the integration of environmental issues with planning policy and sustainability principles.

The *Planning Strategy for Metropolitan Adelaide* introduced the concept of an urban boundary for metropolitan Adelaide (Government of South Australia, 2007). The *Planning Strategy for the Outer Metropolitan Adelaide Region* also contains urban containment boundaries for rural towns in the Barossa, Southern Fleurieu and Central Adelaide Hills (Government of South Australia, 2007). The purpose of the boundaries is to:

- define the physical extent of urban growth
- protect viable agricultural land
- provide for open spaces and the Hills Face Zone
- clearly divide residential land from rural land in order to prevent inherent conflicts
- promote more compact urban forms
- maximise value from infrastructure in urban areas
- protect the watersheds of the Mount Lofty Ranges from further intensification of urban areas.

The Yorke Peninsula Regional Land Use Framework was adopted as a volume of the Planning Strategy on 13 December 2007. The Framework will guide future development across the Yorke Peninsula and Wakefield Plains Region and includes specific objectives and strategies to protect the region's natural resources (Government of South Australia, 2007).

In July 2003 the Development Regulations were amended to require the referral to the EPA of all new housing development applications including those for replacement of existing houses within the Mount Lofty Ranges Watershed. The EPA has the power to direct the Council or Development Assessment Commission to either refuse the development application or impose conditions on its approval. The continuing development of housing on environmentally sensitive sites in the watershed prompted this amendment. In 2005, the EPA defined three protection areas within the Mount Lofty Ranges Watershed based on development control objectives.

Development controls within each of the areas are based on risks to drinking water supplies and national best practice watershed management. The approach seeks to find a balance between best practice watershed protection and development that is achieved through a risk-based planning hierarchy, where land use and development are matched to the risk posed to the drinking water supply.

The subdivision of the Watershed into three water protection areas has been incorporated as a policy into Section 3.1 of the August 2006 *Planning Strategy for the Outer Metropolitan Adelaide Region* (Planning SA 2006).

The introduction of the *Natural Resources Management Act 2004* introduced an integrated framework to manage impact of land use change on South Australia's natural resources. It provides a transparent natural resources management system to ensure South Australia's natural resources are used sustainably and integrates a number of previously separate administrative arrangements into one system. It also brought together the people and expertise needed to deliver integrated approaches

The Act also established linkages between natural resources and water allocation plans developed under its auspices and planning policy from the Development Act.

Eight regionally based, community driven Natural Resources Management (NRM) Boards and a Natural Resources Management Council were established under the Act.

The Council is South Australia's peak advisory body for natural resources. Under the Act, the Council and regional NRM Boards are required to develop plans known collectively as the State NRM Plan and Regional NRM Plans.

The State NRM Plan is South Australia's big picture plan for dealing with threats to our natural resources and opportunities for the long-term sustainable use of those resources. It is a plan to guide and coordinate government, industry and community in the use, management and protection of the state's natural resources.

Regional NRM Plans set out the long-term vision for the region and guide the actions of regional NRM Boards and others over three to five year timeframes.

The government is undertaking a review of the administration of the *Native Vegetation Act 1991* and its Regulations, to better integrate the management of natural resources including native vegetation, by improving legislation, administration, communication, and regional involvement.

A regulation to declare commercial forestry a water affecting activity in the South East came into effect in June 2004.

On 31 July 2007, the Minister for Environment and Conservation announced that the direct extraction of water from shallow water tables (≤ 6m) by plantation forestry in the Lower South East would also be regulated as a water affecting activity. The impact of extraction by new plantation developments is to be offset with an appropriate licensed water allocation. For further information refer to the *Impacts of Commercial Forestry* document at: **www.dwlbc.sa.gov.au/water/1overview/comercial_forestry/index.html**

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Market gardening, Northern Adelaide.
Photo: Monica Moss

What more should we be doing?

The Environment Protection Authority recommends the following:

R4.1 Preserve suitable land for economic agricultural production and biodiversity conservation, recognising that land supply is finite and the demand for housing is growing.

R4.2 Ensure that any potential expansion of commercial tree planting does not compromise natural resources, including local biodiversity, and is accounted for within water allocation planning.

Alignment of Recommendations with South Australia's Strategic Plan targets

	R4.1	R4.2
Growing Prosperity	T1.22	
Improving Wellbeing		
Attaining Sustainability	T3.1, T3.7	T3.1, T3.2, T3.3, T3.9
Fostering Creativity and Innovation		
Building Communities	T5.9	
Expanding Opportunities		

For further detail on South Australia's *Strategic Plan* visit **www.stateplan.sa.gov.au**

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Planning SA
www.planning.sa.gov.au

Soil Erosion and Acidity

Trends

- Rates of soil loss to water and wind erosion in South Australia: SLOWLY **DECLINING** but unsustainable levels of soil loss still occur during extreme weather events.
- The protection of agricultural cropping land from erosion: **SLOWLY BUT STEADILY INCREASING.**
- Extent of acid soils and rates of soil acidification in South Australia: **INCREASING** and will continue to increase unless the remedial action is significantly increased.

Goals

T3.3 Soil protection: By 2014, achieve a 20% increase in South Australia's agricultural cropping land that is adequately protected from erosion. (baseline year is 2003)

South Australia's Strategic Plan 2007

Soil Erosion and Acidity and a sustainable South Australia

Erosion and acidity are natural processes in the Australian landscape. However, since European settlement land use and management practices have increased their occurrence.

There are approximately 10.4 million hectares of land used for agriculture in South Australia. Most has been cleared of its native vegetation and over time almost all has been significantly changed by land management practices such as grazing, tillage, the introduction of exotic flora and fauna and the application of fertilisers, herbicides and pesticides.

Soil erosion and soil acidification are two of the most significant problems that have resulted from agricultural land management practices. Without intervention, they can permanently reduce the productive capacity of agricultural lands and have adverse social, economic and environmental impacts.

Erosion occurs when soil particles are washed or blown from one site to another and results from a complex interaction of climatic conditions, soil type and topography, and is exacerbated by land management practices.

While erosion does occur in undisturbed natural environments, soil is usually lost from agricultural land at a rate many times higher than occurs in natural systems. Large scale erosion occurs when extreme rainfall or winds act on loose soil that is inadequately protected by standing vegetation or plant residues. Climate change is likely to increase soil erosion given that it is expected to deliver a dryer climate with an increase of severe weather events. Further research into adaptive responses to climate change is necessary. Map 4.1 details projected changes to wind erosion potential under reduced rainfall conditions, demonstrating the likely management challenges ahead.

Many soils are naturally acidic and increasing acidification is a natural process affecting susceptible soils where rainfall is high enough to leach nitrates and base-forming nutrient cations (calcium, magnesium, potassium and sodium). Agriculture increases the rate of acidification through the use of nitrogen fertilisers, growing legume plants (especially pasture species), the harvesting of agricultural products and leaching of base forming cations from the soil. Shallow rooted annual species exacerbate the process because they are unable to retrieve and recycle nitrogen and leached cations from depth. Strong acidity can permanently reduce the fertility of clay minerals and if it develops to the point where subsoils are affected, is very difficult to treat.

Strongly acid soils are likely to cause nutrient deficiencies and/or toxicities that can severely reduce plant production. In turn, poor plant vigour is likely to contribute to rises in the watertable and dryland salinity, as well as soil erosion.

The rates and extent of soil acidification continue to increase in the most productive agricultural areas, while rates of soil erosion have declined somewhat, although not nearly to a level that will ensure long term sustainability.

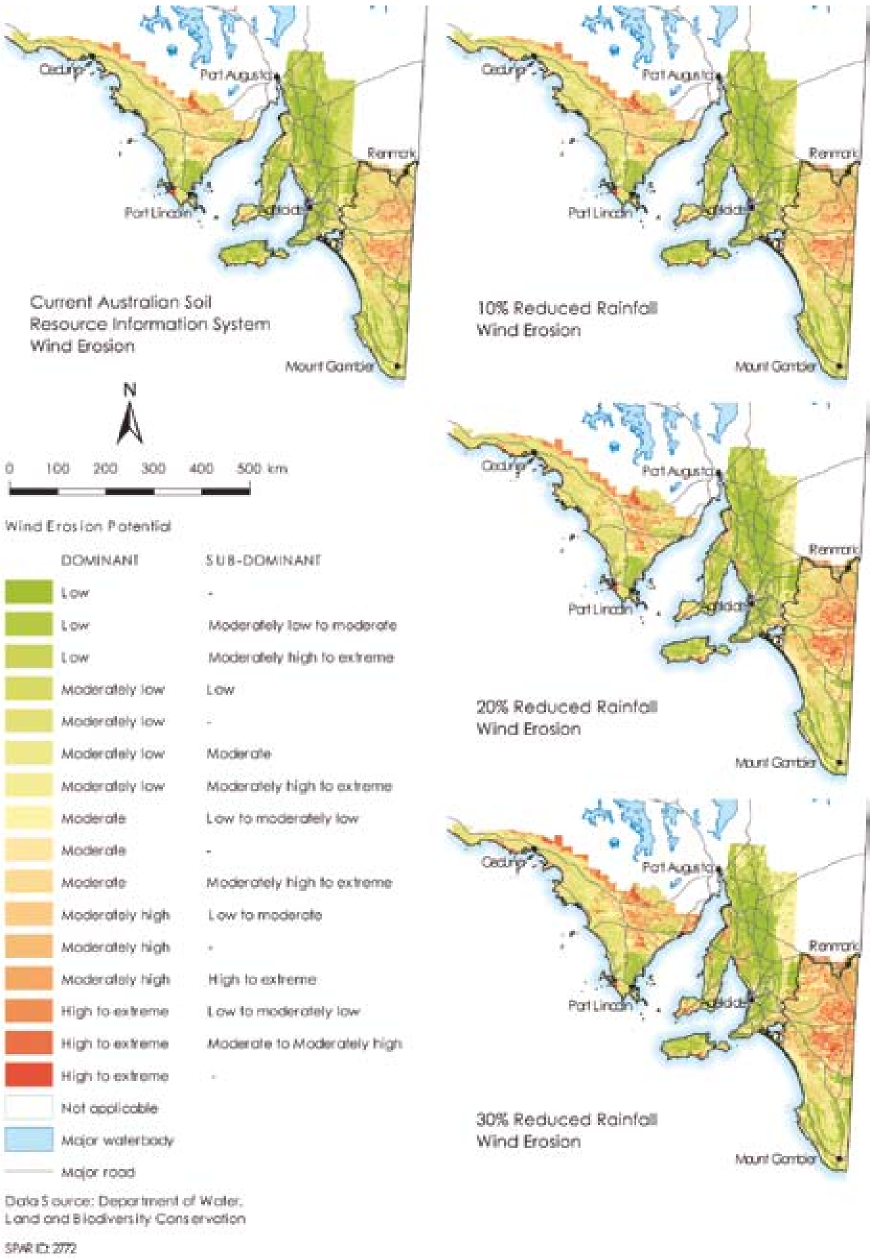
Key Facts

No tillage sowing involves sowing the seed in a narrow slot in the soil to minimise soil disturbance and maximise residue protection on the soil surface. Photo: DWLBC

- The critical management practices that affect the risk of soil erosion are:
  - The occurrence, intensity and timing of tillage operations
  - The quantity and nature of surface cover.
- The timing of tillage operations is of utmost importance because the longer a soil is left in a loose, bare state the higher the probability of a coincident erosive wind or rainfall event.
- The rate of lime application in most agricultural regions is still significantly lower than that required to balance the annual soil acidification rate, except for the South East.

Sowing a crop using the direct drill method. The adoption of improved land management practices, particularly no-till sowing and direct drill sowing combined with stubble retention, has greatly increased the protection of cropping land from soil erosion. Photo: DWLBC

Map 4.1: Wind erosion potentail by reduced rainfall scenarios



Productivity decline

Increased acidity can lead to poor plant growth and reduced water use and productivity as a result of nutrient deficiencies or imbalances and/or induced aluminium or manganese toxicity.

Organic matter and most nutrients critical for plant growth are usually concentrated in the topsoil (the upper 10 cm or so of the soil profile). Subsoils (those below 10cm) are generally infertile and can often be hostile to root growth due to naturally high pH, sodium or salinity. Any loss of topsoil by erosion or other degrading process can cause large scale and very long-term declines in productivity.

In 2002 the Department of Water, Land and Biodiversity Conservation (DWLBC) estimated the on-site costs of wind erosion in the agricultural areas of South Australia to be around $8 million per annum. Of this, the cost of lost nutrients amounted to approximately $6 million and lost productivity caused by sand-blasting of crops accounted for the remainder

Soil acidification has caused a decline in productivity in higher rainfall areas, namely the South East, Kangaroo Island and the Mount Lofty Ranges. On very acidic soil, productivity can be reduced by more than 50%. Low productivity of crops and pastures leads in turn to an increase in the amount of water leaching to the watertable, contributing to dryland salinity.

Subsoil acidity is very difficult and expensive to treat. Conventional methods such as lime applications at the surface, have little impact on the subsoil due to their low solubility.

Degradation of watercourses and water resources

Water erosion can cause off-site degradation of watercourses, wetlands, estuarine areas and the marine environment due to siltation, turbidity and increased nutrient levels. The leaching of nitrate and metals, such as aluminium, associated with soil acidification can cause pollution of water resources and so pose a health risk for both livestock and humans.

Acid sulphate soils are naturally occurring soils and sediments containing iron sulfides that are a risk to waterbodies, vegetation and aquatic life. This is because of their potential to generate acid and release toxic substances.

The exposure of the sulfide in these soils to oxygen by drainage or excavation leads to the formation of sulphuric acid. Potential acid sulfate soils occur in low-lying coastal environments as well as in water logged or low lying inland areas. Acid sulfate soils are covered in greater depth in the ***River Murray*** chapter, which describes the considerable problem they pose due to record low inflows to the river, and also in the ***Coastal and Marine Resources*** chapter.

Impacts on infrastructure

Wind and water erosion can damage buildings and other infrastructure, plant and equipment as well as incur the significant cost of removing soil from roads. For example, as a result of a severe wind erosion event in the Murray Plains District in June 2003, six roads were closed in the Mid Murray District Council area and a further 15 required intensive grading to be kept open. Dust from wind erosion increases the cost of cleaning buildings, air conditioning systems and electricity transformers.

Impact on rural communities

Landholders can suffer long term economic losses due to reduced productivity, and/or have the additional cost of rehabilitating degraded areas. Loss of farm income has a direct impact on local and statewide economies.

Atmospheric pollution and human health

Wind erosion dust storms result in atmospheric pollution and may disrupt the way in which people go about their lives in both rural and urban areas. Dust storms can reduce visibility, cause nuisance through airborne dust, and also cause off-site impacts such as disruptions to aviation and road traffic incidents. Wind-blown dust reduces air quality and is implicated in the occurrence of asthma and associated health problems.

The majority of information presented in this report has been sourced from an annual land condition monitoring program conducted by DWLBC since 1999 (McCord 2004). The program's soil erosion component assesses the extent to which land is protected or at risk from erosion. Direct measurement of actual soil loss is technically impractical. The aim is to provide a quantitative indicator of changes in protection or risk due to management practices over the long-term.

Any change in erosion protection or risk is expected to translate into a proportionate change in the overall rate of soil loss.

The soil acidification information is estimated indirectly using models that incorporate soil type, climate and production systems, and levels of lime use. Baseline information on acidity and other soil and land characteristics has been derived from the *State Land and Soil Mapping Program* (DWLBC, 2007).

Stubble burning. Photo: DWLBC

Wheat growing in canola stubble. Photo: DWLBC

Wind erosion damages fences, roads and other infrastructure and removes organic matter and other nutrients from the soil. Any loss of topsoil by erosion can cause large and very long-term declines in productivity. Photo: DWLBC

Indicators

PRESSURE INDICATORS

- **Agricultural land with an inherent susceptibility to wind and water erosion**

This measures the area of cleared land requiring special management measures to avoid unacceptable soil loss.

- **The area of land at risk from soil acidity.**

This indicates the areas of cleared land at risk from significant soil acidification.

RESPONSE INDICATORS

- **The protection of South Australia's agricultural cropping land from erosion**

This is expressed as the average number of days per year that agricultural cropping land is adequately protected from erosion.

- **Land and crop management practices – soil acidity**

The application of lime is the main response indicator for soil acidity.

What is the current situation?

Most of the 10.4 million Ha of land used for agriculture in South Australia has an inherent susceptibility to soil erosion as determined by its soil texture, slope and climatic conditions such as extended dry periods or high rainfall events.

Wind erosion potential

Sandy textured soils in regions with low rainfall and the high likelihood of extended dry spells are the most susceptible to wind erosion. Approximately 6.0 million Ha or 58% of agricultural land is inherently susceptible to wind erosion with the majority of this in the Eyre Peninsula, Murray Darling Basin, South East and Northern and Yorke Natural Resource Management (NRM) regions (Table 4.2).

Of this, 2.2 million Ha (21 %) is categorised as having a moderate to moderately high susceptibility due to sandy soil types and an elevated topographic position, i.e. sandy rises and sandhills. Although arable this land requires special management practices to prevent erosion. A further 3.6 million Ha is categorised as having moderately low susceptibility to wind erosion. While land in this category is still prone to erosion it has higher clay content, low topographic position or may occur in high rainfall areas, characteristics that make it more resistant to erosion.

Water erosion potential

Approximately 1.2 million Ha or 12% of the state's cleared agricultural land have a moderate to moderately high inherent susceptibility to water erosion (Table 4.3). Special management measures are needed to avoid unacceptable soil loss, even though the land is arable. The key factors that predispose it to water erosion are soil type and slope.

The Northern and Yorke NRM region has the greatest proportion of land in this category, with 562,000 Ha or 45% of the land having a moderate to moderately high inherent susceptibility to water erosion. A further 1.7 million Ha of cleared agricultural land have a moderately low susceptibility to water erosion, with around 1.3 million Ha or 80% of that land located in the Eyre Peninsula, SA Murray Darling Basin and Northern and Yorke NRM regions.

Land with an inherent susceptibility to erosion is unlikely to suffer from erosion if the soil is left undisturbed and a layer of plant matter protects the surface. However, once the surface is loosened and the protective plant cover removed, even low energy winds or water flows are able to erode the soil. Management practices that loosen the soil also inevitably result in a loss of surface cover and so the critical management practices affecting erosion risks are the occurrence, intensity and timing of tillage operations and the quantity and nature of surface cover.

The timing of tillage operations is of utmost importance because the longer a soil is left in a loose, bare state the higher the probability of a coincidental erosive wind or rainfall event.

Of the total area of land used for farming in South Australia, approximately 8.1 million Ha (80%) is used for annual cropping and pasture production i.e. the wheat and sheep zone. The remaining 2.1 million Ha are in the state's high rainfall areas where the dominant land use is perennial pasture with a low risk of erosion.

Table 4.2: Area of cleared agricultural land with soils inherently susceptible to wind erosion by NRM regions in South Australia

NRM REGION	Low '000 Ha	Moderately low '000 Ha	Moderate to moderately high '000 Ha	High and above '000 Ha	TOTAL
	Arable			Non-arable	
Adelaide & Mt Lofty Ranges	343	42	9	1	395
Eyre Peninsula	307	1,698	802	32	2,839
Kangaroo Island	133	80	14	2	228
Northern & Yorke	1,385	566	217	11	2,178
SA Murray-Darling Basin	1,118	670	682	43	2,513
South East	1,069	564	469	133	2,234
TOTAL	**4,355**	**3,619**	**2,192**	**221**	**10,387**
Percentage	**42%**	**35%**	**21%**	**2%**	**100%**

Source: (DWLBC, 2007).

Table 4.3 Area of cleared agriculture land with soils inherently susceptible to water erosion by NRM regions in South Australia

NRM REGION	Low '000 Ha	Moderately low '000 Ha	Moderate to moderately high '000 Ha	High '000 Ha	Very High to extreme '000 Ha	TOTAL
	Arable			Non-arable		
Adelaide & Mt Lofty Ranges	94	47	138	83	32	395
Eyre Peninsula	2,139	463	217	14	6	2,839
Kangaroo Island	109	50	58	7	6	230
Northern & Yorke	1,057	462	562	68	30	2,178
SA Murray-Darling Basin	1,784	404	211	84	31	2,513
South East	1,938	234	62	0	0	2,234
Total	**7,121**	**1,660**	**1,248**	**256**	**104**	**10,389**
Percentage	**69%**	**16%**	**12%**	**2%**	**1%**	**100%**

Source: (DWLBC, 2007)

Water erosion removes topsoil and can cause off-site degradation of water resources and waterways through siltation, turbidity and increased nutrient levels. Photo: DWLBC

About 5.2 million Ha (64%) of land within the wheat and sheep zone are susceptible to wind erosion while 2.4 million Ha (30%) are susceptible to water erosion. Most of these erosion risks are due to cropping practices such as tillage and stubble burning. Around half the land in this zone is being cropped each year.

Grazing management is a very important component of managing soil erosion risk, especially in dry years and droughts. Livestock grazing reduces the soil's vegetation cover soil and can loosen its surface. Generally the highest grazing risks occur in late summer and autumn when feed availability and the cover of annual crop and pasture residues is declining.

Soil Acidity

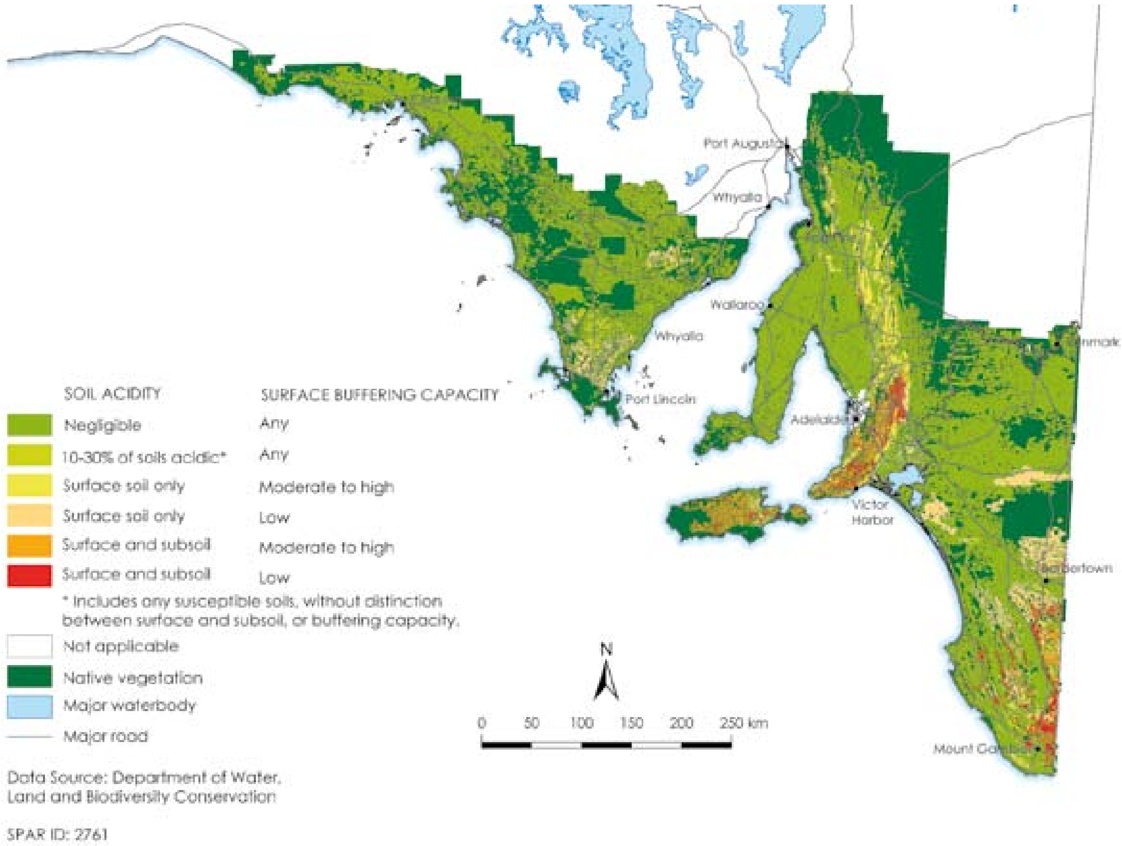
Soil acidity is relatively widespread across South Australian agricultural land, but on a smaller scale than most other states. Accelerated acidity due to agricultural activities has caused a decline in productivity, to date mostly affecting under improved legume pastures in higher rainfall areas. However, it is now emerging as a major issue because rates of acidification have increased significantly in parallel with increases in intensity of cropping and productivity. Extensive soil survey data collected by the DWLBC identifies areas currently exhibiting soil acidity. Approximately 1.9 million Ha (20%) of cleared agricultural land are affected by soil acidity.

Land that is susceptible to soil acidification includes that which is neutral or acidic. It also has low clay content and no free lime, together with a relatively high rainfall and production levels. Much of this land is already showing production losses to some extent.

The South East region has the largest area exhibiting significant soil acidity at around 647,000 hectares (35% of the state's total acidic soils). Of the other NRM Regions, Kangaroo Island and the Mt Lofty Ranges have the highest proportion of land affected by acidity with 185,000 Ha (80%) and 266,000 Ha (67%) respectively. In addition, there are 312,000 Ha affected by acidity in the Northern and Yorke region, 263,000 ha in the SA Murray Darling Basin and 180,000 ha, in the Eyre Peninsula NRM.

Strongly acidic soils occur exclusively in high rainfall areas, where soil acidification poses the greatest risks to productivity, water quality and the environment (Map 4.2).

Map 4.2: Soil acidity, South Australia



What are we doing about it?

RESPONSE INDICATOR: The protection of South Australia's agricultural cropping land from erosion

Despite major improvements in land management over the past 50 years including a recent upswing in the adoption of no-tillage farming, large areas of cropping land are at unreasonable risk of erosion through the use of high-risk farm management practices. Challenges such as herbicide resistance, crop diseases and stubble management remain to be to overcome in achieving overall sustainability using lower risk practices.

When monitoring erosion, the approach of the DWLBC land condition monitoring program is to measure changes in key practices affecting the risk.

Risk indices are derived from simple groundcover, surface looseness and soil or landscape ratings, as well as the periods of time the land is at risk. DWLBC risk assessments are calculated using data from field surveys across 5,500 sites four times a year.

A key part of the program has been to measure the cumulative period of time that cropping land is either protected from or at risk of soil erosion during the year, based on the level of groundcover. This is expressed as the average number of days of adequate protection for each hectare of cropland across the state per year. For example, if all cropping land in the state is adequately protected for nine months of the year, then the average protection would be 275 days.

Variations in seasonal conditions can lead to considerable variations in erosion protection between years. To even out the seasonal impacts, the protection of cropped land from erosion is expressed as a three-year rolling average.

The soil protection target (T3.3) in *South Australia's Strategic Plan 2007* is to achieve a 20% increase in South Australia's agricultural cropping land with adequate protection from erosion in the period 2003 to 2014. This will require an increase in protection of 54 days per year, from 272 days in 2003 (baseline year) to 326 days in 2014.

From 2002-03 to 2006-07 there has been a slow but steady improvement in the protection of agricultural cropland from erosion (Figure 4.2). By 2006-07 the level of protection had increased by 18 days to 290 days, a 6.7% improvement over 2002-03. Due to the negative impact of drought during 2006-07, there was minimal improvement in protection compared to 2005-06.

Changes in farming practices

The improvement since 2003 in protecting cropping land from erosion is attributed to an increase in the adoption of improved land management practices, particularly no-till sowing and direct drill sowing, combined with stubble retention. No till sowing is the most significant practice for protecting cropland from erosion and involves sowing the seed in a narrow slot in the soil to minimise soil disturbance and maximise residue protection on the soil surface. Direct-drill sowing the land involves ploughing, but only during sowing.

Land management telephone surveys conducted for DWLBC show that the proportion of crop area sown using no-till methods has increased from 13% in 2000 to 47% in 2005 (Figure 4.3).

The greatest change has occurred in the Murraylands region, where the proportion of no till sowing increased from just 7% in 2000 to 14% in 2002 and to 40 % 2005 (Figure 4.4). It has been a remarkable change to long-established practices in a short time.

The use of clay spreading and delving to manage water repellent soil is becoming a significant factor in the protection of soils from wind erosion. By increasing the clay content of the surface soil, clay spreading and delving increase soil strength and resistance to erosion. The process also improves crop and pasture production, giving higher levels of plant cover to protect the soil from erosion. These techniques are widely used in the southern mallee and upper southeast areas where there are large areas of severely water repellent soils.

Improved grazing management practices, such as rotational grazing and confinement feeding, are also improving protection for agricultural land from erosion. Confinement feeding enables stock to be removed from paddocks before surface cover declines below critical protective levels. It is a very important technique for preventing erosion during droughts and in late summer and autumn when ground cover is declining. It is most valuable in the management of wind erosion on sandy soils since heavy grazing by stock can loosen the surface of these soils making them more vulnerable. It is also important to prevent further areas becoming susceptible to erosion and acidity due to clearing and to recognise the opportunities that revegetation or regeneration may provide to reduce erosion from grazing activities.

A wide range of community, industry and agency projects focused on educating and informing landholders and encouraging best practice have driven the adoption of management practices that reduce the risk of soil erosion. The increased prevalence of these practices reflects a growing desire by farmers to use more sustainable methods.

RESPONSE INDICATOR: Land and crop management practices – soil acidity

Improved land and crop management practices, particularly lime applications, have gone some way to improving soil condition over the past 50 years, although the rate of adoption of sustainable land management practices is still not as extensive as it needs to be. While lime application effectively treats soil acidity, better management of nitrogen-based fertiliser regimes and the use of deep rooted perennial pastures such as lucerne, can also influence the speed at which it develops in agricultural areas.

Application of agricultural liming materials and clay

Within conventional agricultural systems, the only practical way to balance the acidification caused by agriculture is to apply liming materials. Monitoring the use of lime provides an indirect measure of the extent to which farmers have both recognised and addressed soil acidification.

Although rates of lime use have risen substantially since the mid-1990s, most regions have shown a subsequent decline in lime use in recent years (Figure 4.5). The estimated amount of lime required to balance the annual acidification rate across the state is approximately 211,000 tonnes. In 2006/07 approximately 74,000 tonnes of lime was applied, slightly more than a third of that required. Very large areas of land are continuing to acidify to damaging levels. Despite the relatively low cost of lime in South Australia in

Figure 4.2: Trend in the average annual period of protection of agricultural cropping land from soil erosion, South Australia 2001/02-2006/07 (days per year, 3 yr rolling mean)

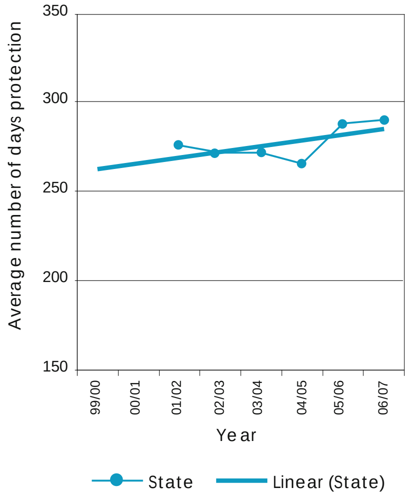


Figure 4.3: Change in the proportion of crop area sown using no-till and direct drill methods, South Australia

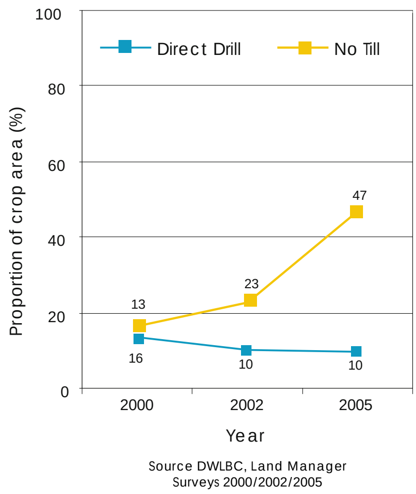
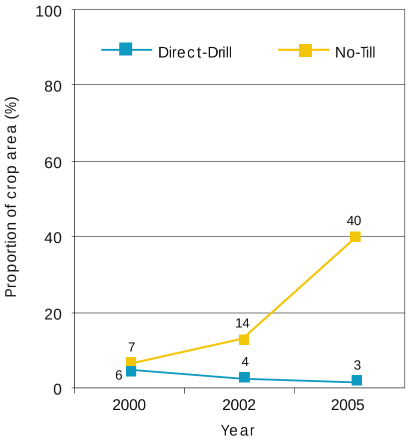
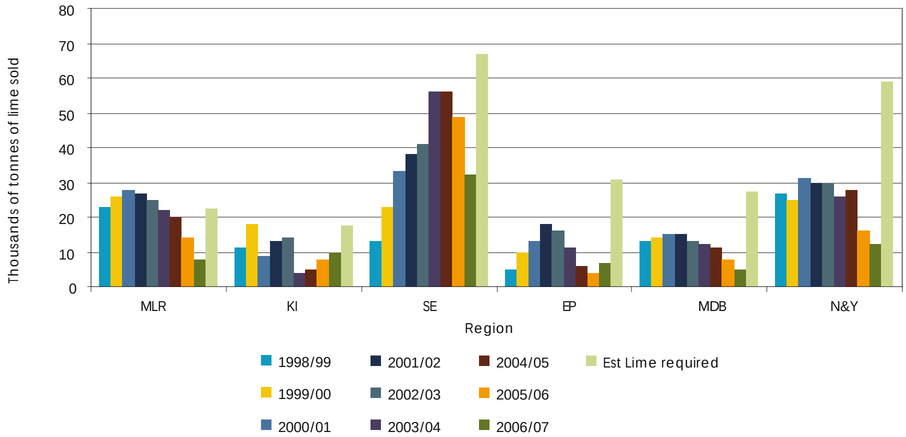


Figure 4.4: Change in the proportion of crop area sown using no-till and direct drill methods, Murraylands Region of South Australia



Source DWLBC, Land Manager Surveys 2000/2002/2005

Figure 4.5: Estimates of the amount of lime required to balance the annual acidification rate and the total lime sold from 1998/99-2006/07



Note: regional lime sales data is approximate only due to difficulties in delineating lime sales between regions

comparison to other states, farmers often cite cost as a key barrier to its use.

Large areas of South Australia's soils that are most at risk of acidification are now being ameliorated through clay spreading and clay delving. Many of the clays used are alkaline, will raise pH significantly and will also improve the soil's capacity to withstand acidification. Some also have free lime present and that will generate longer-term pH rises. The addition of clay is also a successful treatment for water repellent soils.

The use of alkaline irrigation water can also ameliorate the impact of soil acidity. This is particularly relevant in the South East of the state, and to a lesser extent in the Northern and Yorke, and Adelaide and Mount Lofty Ranges regions.

Consequences of subsurface and subsoil acidity

In South Australia's high rainfall environments such as the South East, Kangaroo Island and the Mt Lofty Ranges, acidification of surface soil may eventually lead to acidification of the subsurface and subsoil unless there are regular applications of lime.

Once established, lower profile acidity is difficult to address due to lime's low solubility. Lime movement is related to rainfall and soil type. However, even in sandy soils in high rainfall environments lime moves down the profile very slowly, at a rate of only a few centimetres per year and below about 20cm it ceases to have a significant impact. Expensive amelioration techniques such as lime slotting, clay delving and irrigation with alkaline water can sometimes be effective.

PROGRAMS AND POLICY

The South Australian Government has highlighted the importance of sustainable soil management under the Attaining Sustainability objective of the state's *Strategic Plan 2007* through the inclusion of Target T3.3 - Soil Protection: *"By 2014, achieve a 20% increase in South Australia's agricultural cropping land that is adequately protected from erosion".*

Achievement of the target will require a collaborative effort between the state government, regional groups, farming industry organisations, community groups and individual farming businesses.

The State Natural Resource Management Plan and the regional framework for delivery of NRM programs in South Australia, established through the Natural Resources Management Act 2004, are instrumental to achieving the objectives of *South Australia's Strategic Plan*. The State NRM Plan 2006 identifies a 50-year vision for NRM in South Australia, and sets out policies, milestones and strategies to achieve that vision, including addressing soil erosion and acidity.

Under the NRM Act regional NRM Boards have been established across the state. The Boards have the responsibility for developing and maintaining comprehensive regional NRM plans

South Australian No-Till Farmers Association

The South Australian No-Till Farmers established 10 years ago as a with a focus on sustainable farming to be one of the most successful state with more than 1,150 members.

The Association's aims are:

- To promote the role of conservatio tally sustainable farming practice.
- To communicate information betw tion agriculture.
- To provide innovative research to further the productivity of conservation agriculture.

SANTFA has established demonstrations and trials of no-tillage farming systems across South Australia. Photo: SANTFA

The Association is a not-for-profit farmer driven organisation that is led by a board of volunteers who are assisted by a full time Research and Development Manager and a part time Executive Officer.

SANTFA provides education and information for growers who are seeking to adopt better practices as well as growers who require support to further advance their established conservation farming system. In both cases, the focus is on options that enable farmers to meet the triple bottomline outcomes of economic, environmental and social sustainability.

For more details on the SA No-Till Farmers Association visit the website: **www.santfa.com.au**

describing their goals in relation to natural resources management, targets for natural resource condition, and policies and programs to achieve them. The development and achievement of regional targets to protect cropping land from soil erosion will be a key step in achieving the statewide Soil Protection target. The Boards will also provide the collaboration and coordination needed at the regional level.

Regional NRM Boards and industry require information on current status and trends in the protection of cropping land from erosion as well as soil erosion risks, such as dry seasons, and how to manage them. The land condition monitoring program conducted by DWLBC since 1999 plays a pivotal role in informing NRM Boards, industry and agency partners of key issues and current trends in wind and water erosion and soil acidity to improve their capacity to develop and implement appropriate programs.

The South Australian Government is currently involved in a range of projects aimed at increasing the adoption of sustainable farming practices such as no-till farming, in partnership with the National Landcare Program, regional farming systems groups and regional NRM Boards.

The growth of regional farming systems groups in all the agricultural regions of the state over the last five to 10 years, as well as statewide organisations such as the South Australian No-Till Farmers Association, reflects the enthusiasm within the rural sector for exploring new sustainable technologies. The activities of these bodies adds to the work being done at the local level by Landcare groups, branches of the South Australian Agricultural Bureau and other community groups.

Clay spreading to overcome water repellance in sandy soils also assists with the control of wind erosion and management of soil acidity.
Photo: DWLBC

What more should we be doing?

The Environment Protection Authority recommends the following:

R4.3 Continue to improve soil conservation through appropriate crop selection, fertiliser use and good land management practices.

Alignment of Recommendations with South Australia's Strategic Plan targets

	R4.3
Growing Prosperity	T1.1, T1.14
Improving Wellbeing	
Attaining Sustainability	T3.3, T3.7
Fostering Creativity and Innovation	
Building Communities	T5.9
Expanding Opportunities	

For further detail on South Australia's *Strategic Plan* visit **www.stateplan.sa.gov.au**

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www.msfp.org.au

National Landcare Programme
www.daff.gov.au/natural-resources/landcare/national-landcare-programme

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www.nrm.sa.gov.au/Home.aspx

Primary Industries and Resources SA
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Dryland Salinity

Trends

- Shallower groundwater levels throughout the State have generally exhibited a **DECREASING** trend, most likely due to recent below-average rainfall. The exception to this has been areas that have not been as severely affected by extended below-average rainfall, for example Kangaroo Island.
- Deeper groundwater levels throughout the State have generally exhibited a **STABILISING** trend, most likely due to the extended period of below-average rainfall since the mid 1990s, with the exception of the areas that have not been as severely affected by extended below-average rainfall.
- In the short-term there is generally a **REDUCED** RISK of dryland salinity in areas that have experience lower than average rainfall since the mid 1990s.

Goals

Protect land resources from salinisation, minimising any additional area of land affected by dryland salinity beyond year 2000 levels (approximately 330,000 Ha).

- Protect our natural environment, water and biodiversity resources, keeping salinity impacts to current levels or where possible, reducing them.
- Protect our economic resource base, developing productive uses for irreversibly saline land and water.

South Australian Dryland Salinity Strategy 2001

Dryland Salinity and a sustainable South Australia

Dryland salinity in South Australia has a significant impact on the state's land, water and biodiversity assets, particularly in broadacre dryland farming areas. In many parts of the state, historical clearance of native vegetation and its replacement with annual crops and pastures has resulted in rising groundwater levels. Rising groundwater causes land to become salt affected and increases saline groundwater discharge to streams. As well as land and habitat degradation, dryland salinity has significant economic and social impacts, particularly in regional communities where there are high costs resulting from lost agricultural production plus salt damage to roads, buildings and other infrastructure.

Salinity poses a threat in all agricultural regions of South Australia. As reported in the *State of the Environment Report* (2003), rising groundwater was expected to have a particularly significant impact on the infrastructure and agricultural land of the Upper South East region.

Salinity is not a new issue in that region, but its severity increased with the advent of widespread flooding during the 1980s and early 1990s. The interdunal flats that characterise the region are particularly prone to flooding in years of above average rainfall. Not only does flooding damage crops, pastures and infrastructure, it also recharges the groundwater system, which further exacerbates the salinity threat.

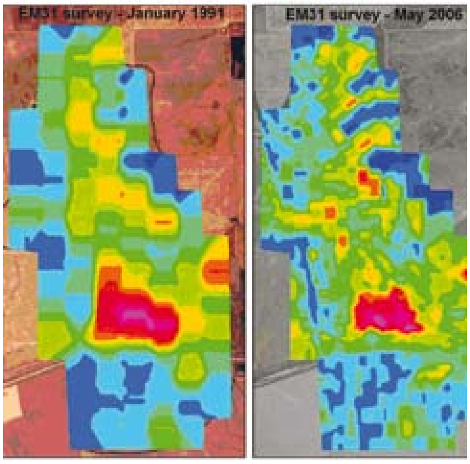
Rural communities are most at risk from dryland salinity and landowners who have these problems can face economic losses through reduced productivity, the need to switch to less profitable enterprises or in severe cases, the inability to continue farming a particular area.

In 2000, the loss in agricultural production as a direct result of dryland salinity was estimated to be $26.1 million and was predicted to increase to $42 million by 2050 (Barnett, 2000). This represents only 1-2% of the statewide gross margin from production on all agricultural land, but the economic burden is spread very unevenly. In affected rural areas, dryland salinity can also cause damage to built infrastructure such as roads, railway

Key Facts

- Ground based EM surveys conducted in focus catchments have shown that in most cases the saltland area has been receding at a rate of 2% to 3% per year since the early to mid 1990s.
- On the low-lying Coastal Plain watertable levels are closely aligned to winter rainfall, not withstanding the impact on draw down by perennial vegetation. No winter recharge was observed during the 2006 drought, with groundwater levels falling about 0.5m to 0.75m below 2003 levels – they are now the lowest recorded since monitoring began in 1980.
- In some areas of the Upper South East, a draw down in groundwater has been observed at a distance up to 2km up-gradient of the drains.
- On Kangaroo Island where a rising groundwater trend has been evident, the area of saltland in a focus catchment has increased at an average yearly rate of 2.5% from 1991 to 2004.

Figure 4.6: Comparison of Jamestown electomagnetic surveys 1991 and 2006



Source: DWLBC

lines and buildings. The life expectancy of sealed roads is reduced and unsealed roads require more frequent maintenance.

The degree of localised impact on valuable agricultural, biodiversity and infrastructure assets from dryland salinity, rather than the spatial extent of the problem across the State should influence decisions for managing the problem recognising that its relative impact depends heavily on the asset value of its locality.

Across agricultural areas and on the River Murray floodplain, numerous biodiversity assets have been identified as under threat from dryland salinity, as well as salinity caused by irrigation. Threatened assets include low-lying remnant native vegetation, wetlands, riparian zones and conservation parks.

In 2000, approximately 18,000 Ha of native vegetation and 45,000 Ha of wetlands were estimated to be affected by dryland salinity (NLWRA, 2001). Particularly significant areas at risk include Biodiversity Hotspots listed by the Endangered Species Advisory Committee (Dooley, 2003) such as Messent and Gum Lagoon Conservation Parks in the Upper South East and Murray's Lagoon on Kangaroo Island. These national parks and wildlife reserves support areas of native vegetation that are of high conservation value.

Since the original baseline assessments of the area affected by dryland salinity (NLWRA, 2001; DWLBC 2005), there has been no revised statewide assessment. Instead focus catchments that are representative of the major regional and local groundwater flow systems in dryland agricultural regions have been selected for assessment as indicators of changes across the state. A variety of information from each catchment is examined including EM surveys, trends in depth to groundwater and type of groundwater flow system, rainfall patterns and changes in landuse (DWLBC, In Press).

Since 2003 below average rainfall with the resulting falling groundwater levels, changes in land use to reduce recharge and the effect of an artificial drainage network constructed in the Mid and Upper South East have affected dryland salinity.

The low rainfall has delivered a stability, in depth to groundwater across South Australia, reducing the threat posed by dryland salinity. In fact, a falling trend in this depth has been evident in representative local groundwater flow systems. A few areas including Kangaroo Island, have not been as severely affected by below-average rainfall and so the falling depth to groundwater trend is less evident.

In focus areas where rainfall has been below-average rainfall for an extend period, ground based EM surveys reveal an associated contraction of salt affected land by 2-3% per year. For deeper groundwater systems, previous rising trends have also now generally stabilised, indicating reduced long-term risk of dryland salinity.

In some areas of the Upper South East, deep drainage has resulted in a draw-down in groundwater at a distance of up to 2km up gradient of the drains, reducing the proportion of land affected by dryland salinity in the area.

This trend is likely to continue with below-average rainfall linked to climate change predicted for the longer term. This is likely to be one of the few environmental benefits of adverse climate change in South Australia. Further research is needed into the full impact of climate change including lower spring/autumn rainfall, increased evaporation and increased frequency of extreme weather events, on salinity extent and risk.

Indicators

CONDITION INDICATOR

- **Area affected by dryland salinity**

Identifies the area of land affected by dryland salinity.

PRESSURE INDICATOR

- **Area threatened by dryland salinity**

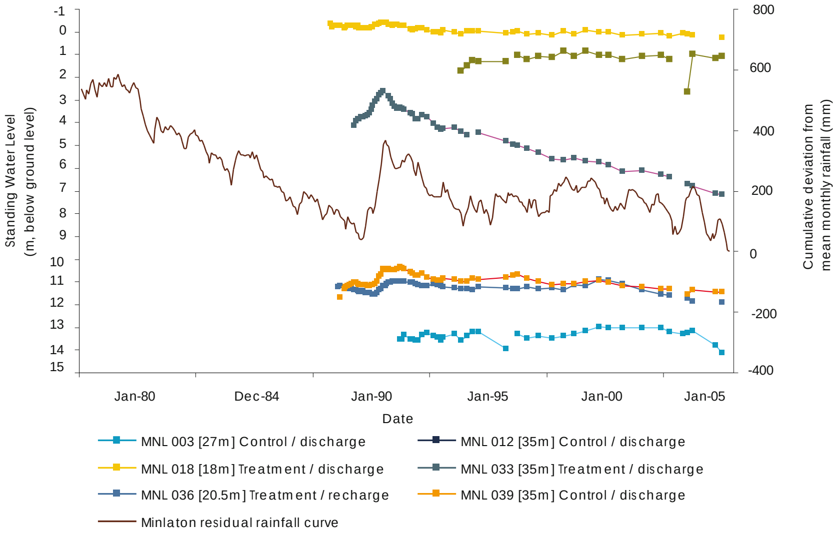
Identifies the area of land at risk from dryland salinity.

What is the current situation?

CONDITION INDICATOR: Area of land affected by dryland salinity

Dryland salinity occurs to some extent across all of South Australia's major agricultural NRM Regions. The area of affected land has been estimated to be more than 300,000 Ha, with

Figure 4.7: Falling groundwater trend and falling (cumulative residual) rainfall, Minlaton focus catchment



Source: SWL data from OBSWELL, Rainfall data from 'SILO Data Drill' [137.60degE, 34.80degS]

Dryland salinity, Hindmarsh Island. Photo: Monica Moss

the Upper South East being the most severely affected region (NLWRA, 2001; DWLBC, 2005).

It has been predicted that by 2050 the total area of land affected by dryland salinity will increase to 521,000 Ha, under normal rainfall conditions and without intervention. Since then, there has been no new statewide assessment of the area currently affected by dryland salinity taking into account recent below-average rainfall, changes in land use to reduce recharge or the effect of the artificial drainage network constructed in the Mid and Upper South East.

The National Coordination Committee for Salinity has agreed that the location, size and intensity of salt affected areas is a useful and scalable indicator, but measuring the extent of salt affected land, while useful for statistical purposes, provides no indication of the hydrological status of a catchment or particular land unit. Trends in the area of salt affected land may give us an idea of past or current processes, but currently cannot be used reliably to predict change (Bureau of Rural Sciences, 2007).

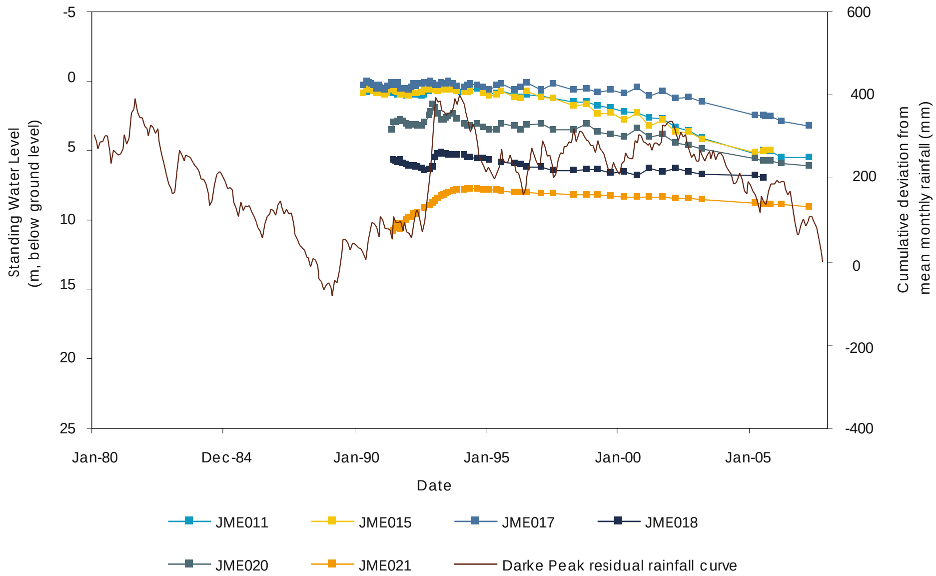
In order to monitor changes in dryland salinity across the state, assessments have been made of a selection of focus catchments that are representative of the major regional and local groundwater flow systems in key dryland agricultural districts across the Upper South East, Northern and Yorke Peninsula, Eyre Peninsula, SA Murray Darling Basin, Kangaroo Island and Mount Lofty Ranges. A variety of information from each focus area was evaluated including ground based EM surveys (see Special Interest Section), trends in depth to groundwater and groundwater flow systems, rainfall patterns and changes in land use (DWLBC, In Press).

In two focus catchments, EM surveys were conducted to measure the change in saltland between 1991 and 2006. The surveys have shown an average decrease in saltland area of 3% per year at Jamestown (Figure 4.6) and 2% per year at Minlaton (2007 Saltland Snapshot Northern and Yorke, In Press). The contraction in saltland relates to a declining trend in depth to groundwater, which in turn parallels a longer-term decline in average rainfall (see Pressure Indicator Section)

Figure 4.6 shows a comparison of Jamestown EM surveys (red = higher salinity) in 1991 (left) and 2006 (right) overlaid on aerial photographs of the area.

At Wanilla and Darke Peake on the Eyre Peninsula, EM surveys were conducted to measure the change in saltland between 1992 and 2005 (2007 Saltland Snapshot Eyre Peninsula, In Press). The surveys showed a decrease of about 2% per year in the area of land affected by dryland salinity at Wanilla. At Darke Peak it has reduced by 2.5% per year. These reductions are again related to the falling trend in groundwater levels that, in turn, correlates with below-average rainfall.

Figure 4.8: Falling groundwater trend since mid 1990s due to falling cumulative residual rainfall, Dark Peake focus catchment



Source: SWL data from OBSWELL, Rainfall data from 'SILO Data Drill' [136.35degE, 33.40degS])

In contrast to the Eyre and Yorke Peninsulas, EM surveys on Kangaroo Island have shown that saltland increased at an average yearly rate of 2.5 % between 1991 and 2004 in the focus catchments (2007 Saltland Snapshot Kangaroo Island, In Press). The increase reflects a rising trend in groundwater levels in response to above-average rainfall over the past decade, although recent years have seen a levelling off in groundwater trends.

Across many agricultural regions of South Australia, where monitoring has taken place, there has been a contraction of saltland due to falling trends in groundwater levels. These falls are most likely a consequence of lower than average rainfall since the mid-1990s. The exceptions are as previously explained, areas such as Kangaroo Island.

While falling trends imply that dryland salinity is not spreading, it does not automatically equate with a contraction in the areas affected. Below average rainfall can also reduce the likelihood of salts being flushed downward through the soil profile (especially in low rainfall areas).

The future extent of dryland salinity and its impact will depend on future rainfall patterns (including the effect of climate change), and the effect of water balance manipulation achieved by improved farming systems and changes in land use. If there is a return to average or above average rainfall, groundwater trends may again rise resulting in further increases in salinity. In the long term and without continued intervention such as broadscale revegetation and salt interception schemes, groundwater discharge and surface runoff to the River Murray will slowly increase its salinity.

Within the Upper South East, it is expected the significant investment in salinity and flood mitigation infrastructure and broadscale adoption of perennials will provide long-term benefits for agricultural land and biodiversity assets.

What are the pressures?

PRESSURE INDICATOR: Area threatened by dryland salinity

Depth to groundwater is generally identified as one of the most useful indicators of land salinity. Monitoring groundwater levels can provide an indication of the current risk of land salinity and an early warning of changes in catchment hydrology that may lead to salinity development (Bureau of Rural Sciences, 2007). Rising trends in average groundwater levels may provide an early indication of an increased land salinity risk in a catchment. Conversely, falling watertable levels may be an indicator of the effectiveness of management strategies (Coram, Dyson & Evans 2001). Both trends can be significantly influenced by climatic conditions.

With lower than average rainfall since the mid-1990s, short-term trends in depth to groundwater are relatively stable and in many instances levels are falling. For deeper groundwater systems, previous rising trends have also now stabilised. If these drier conditions continue in the short term the risk of dryland salinity is likely to be reduced.

Any resumption of average or above average rainfall patterns, will increase the risk of dryland salinity spreading as there are likely to be renewed rising groundwater trends and further increases in the area affected.

The following overview of regional trends in groundwater levels provides key information for assessing the threat of shallow watertables and associated levels of salinity risk.

Upper Southeast groundwater level trends

On the low-lying Coastal Plain, groundwater levels have a close correlation with winter rainfall. Following the 2006 drought, when negligible winter recharge occurred, groundwater levels fell around 0.5m to 0.75 m below 2003 levels during early 2007. These were generally the lowest levels since monitoring began in 1980.

Despite an extended run of lower than average rainfall years very saline groundwater tables remain at shallow depths, often less than 1.5m below the surface in the low-lying parts of the landscape, where drainage is undeveloped and salt accumulation in the upper soil profile is a real threat to pasture and native vegetation. Such groundwater tables respond immediately to rainfall bringing extremely saline groundwater to the surface.

In some areas of the Upper South East, a deep drainage network has resulted in a draw down in groundwater at distances of up to 2km up-gradient of the drains (Telfer, White and Santich, 2002). The draw down effect is responsible for a reduction in area affected by dryland salinity on either side of the drains throughout the network (DWLBC, 2006) however increased soil sodicity is also occurring in many areas affected by the drains. While some studies have focused on the effectiveness of the drains (Morris, Strugnell and Dunsford, 2004; Durkay, 2007), most observations are anecdotal (Senate Enquiry, 2005). A comprehensive evaluation of the effect of the drainage network on the areas affected by dryland salinity has yet to be undertaken. The Upper South East Dryland Salinity and Flood Management Program is preparing to commission such a survey.

Northern and Yorke Peninsula

Rising trends in water levels had been observed in some deeper aquifers on Yorke Peninsula up until 2002. This reverted to a falling trend in 2006-07 (Figure 4.7). In shallow groundwater areas, levels have been falling (Figure 4.7), probably due to a combination of below-average rainfall and land use change, resulting in a recession in saltland area and a reduced risk of dryland salinity.

Many catchments in the Northern and Yorke Peninsula regions are now at or approaching, a water equilibrium (2007 Saltland Snapshot Northern and Yorke, In Press). The area of salt land is expected to spread and recede in line with longer-term rainfall cycles. However, the recent extended below-average rainfall has also highlighted the potential for increased evaporation and reduced vegetative cover to expose and exacerbate the condition of previously covered salt land.

The Eyre Peninsula

Probably due to below-average rainfall, a falling trend in depth to groundwater has been observed for most areas on Eyre Peninsula over the past 15 years (Figure 4.8), although rising groundwater has been recorded for some deeper aquifers in the Eastern Cleve Hills (2007 Saltland Snapshot Eyre Peninsula, In Press). A short-term reduction in land threatened by dryland salinity is inferred by the falling trend.

A spike (rise) in groundwater levels was observed on the Lower Eyre Peninsula following a bushfire in 2005, and a few new outbreaks of salt land resulted (Henschke and Wright 2007). This is a timely reminder that, while many of these catchments may be at water equilibrium, adverse events such as bushfire, flood and climate change, can have a significant impact on salinity.

Kangaroo Island

In some catchments, groundwater has risen in response to above-average rainfall over the past decade (Figure 4.9) and land clearing that occurred up until the 1970s. However, in recent years there has been a general levelling off

Figure 4.9: Falling groundwater trend since mid 1990s due to falling cumulative residual rainfall, Narroonda, Kangaroo Island focus catchment.

Source: DWLBC

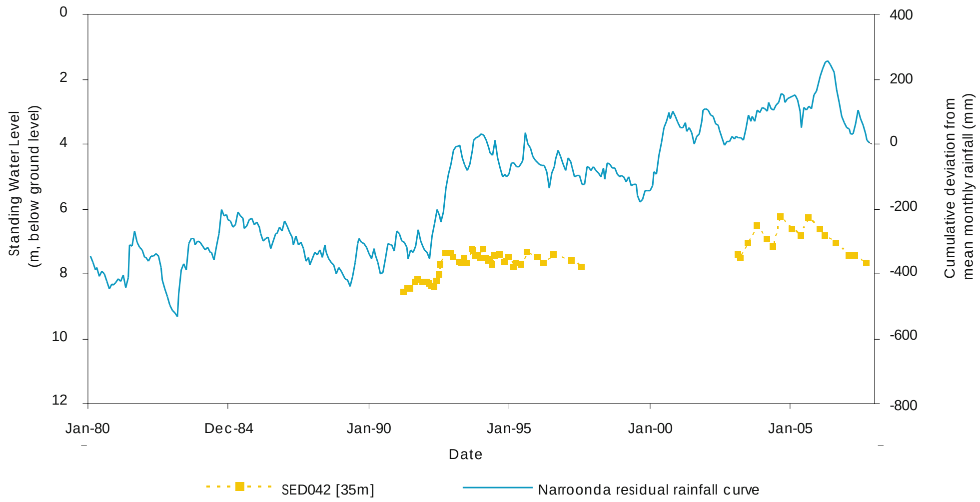
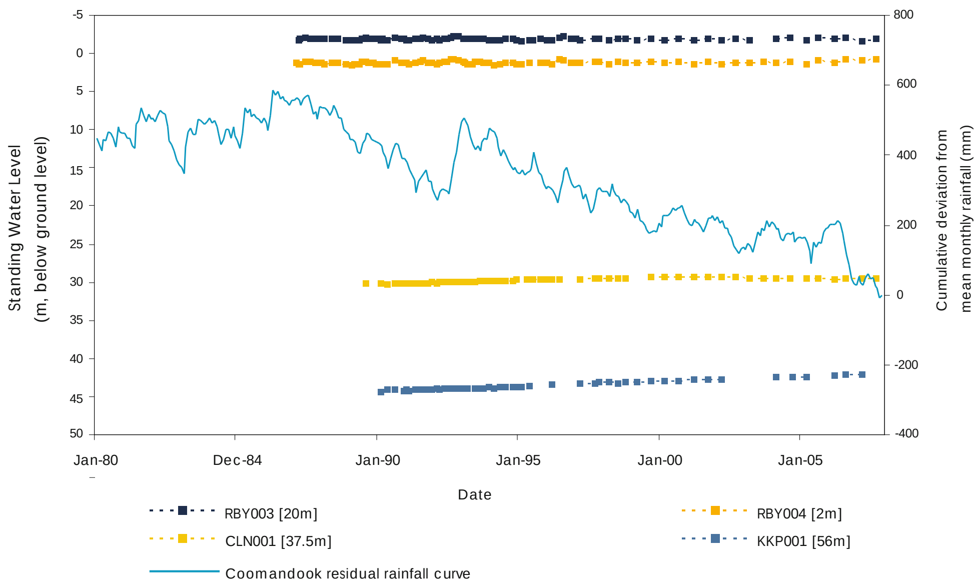


Figure 4.10: Gradual rising groundwater trend and falling (cumulative residual) rainfall, Coomandook focus catchment.

Source: DWLBC



in these trends, with the possibility that equilibrium has now been reached in most catchments (2007 Saltland Snapshot Kangaroo Island, In Press; Henschke, Evans, Liddicoat and Dooley 2005).

Mount Lofty Ranges groundwater level trends

Groundwater levels correlate closely with winter rainfall in this area (2007 Saltland Snapshot Mount Lofty Ranges, In Press), and consequently, levels are about 0.5 m below 2003 levels due to the 2006 drought. Average rainfall has declined since a high point in the early 1990s, with groundwater depth following a similar trend.

Long-term rainfall trends will influence depth to groundwater, but establishing a significant area of a catchment with perennials in these typically local groundwater flow systems (GFS) will reduce recharge and help control future saltland spread.

Detailed analysis (Liddicoat) has shown that the salinity benefits from revegetation in higher rainfall parts of the Bremer Barker Catchment may be more than offset by the negative impacts on surface water flows and therefore, on salinity levels in the Bremer River. Similar scenarios may present in other Mount Lofty Ranges catchments.

SA Murray Darling Basin and River Murray salinity

At Cooke Plains, salt discharges from a regional groundwater flow system emanating from Victoria. Groundwater levels in the deeper regional system have been rising at a rate of 8cm per year since 1990, against a backdrop of below-average rainfall (Figure 4.10) but over recent years, have tended to stabilise with extended dry conditions (2007 Saltland Snapshot SA Murray Darling Basin, In Press).

It is predicted that without continued on-ground action, such as revegetation and drainage to intercept it, groundwater will slowly drain towards the River Murray, significantly increasing its salinity in the future.

A modeling exercise carried out recently (Barnett and Yan, 2006) provided an updated estimate of the impact of rising watertables due to Mallee clearance, on the River Murray salinity level. This analysis used much improved recharge estimates and predicted lag times between clearing and watertable response. Compared to the impact from irrigation drainage, the clearing-induced rise in salinity is expected to be relatively small, amounting to a 20 EC increase at Morgan over the years 2000 to 2050. This is measured against the Basin target of maintaining levels below 800 EC 95% of the time *(Basin Salinity Management Strategy, 2001).*

What are we doing about it?

Where viable options for dryland salinity management do not exist, such as in the broadscale agricultural areas of the Murray Mallee, Eyre Peninsula and Northern and Yorke Peninsula, continued research and development is needed into practical and profitable options for recharge management. This is being addressed by the state government's partnership with the Future Farm Industries Cooperative Research Centre (FFI CRC).

In response to threats posed by dryland salinity the state government initially developed the South Australian Dryland Salinity Strategy in 2001. Since the last SOE report, the *Natural Resources Management Act 2004* (NRM Act) was enacted and the *State NRM Plan* (2006) prepared, setting strategic directions for natural resources management including dryland salinity.

The NRM Act puts greater emphasis on integrated natural resource management rather than single issues such as salinity. This was the basis of the NRM Council's decision to disband the SA Dryland Salinity Committee. However, the Technical Advisory Group still meets and now reports directly to the NRM Council. The Act does provide for the long-term management of natural resource threats including salinity, through NRM Regional Boards .

Implementation of the *South Australian Dryland Salinity Strategy* is a requirement defined in Goal 2 of the South Australian State NRM Plan.

The NRM Regional Boards are working in partnership with State and Australian Governments to devise comprehensive plans that must take into account goals and strategies within the State NRM Plan. This will involve developing relevant agronomic, hydrological and biological programs to tackle salinity and reporting on their progress. The level of effort directed to these programs depends on the magnitude of salinity risk, value of the assets under threat, cost of management actions and likelihood of success.

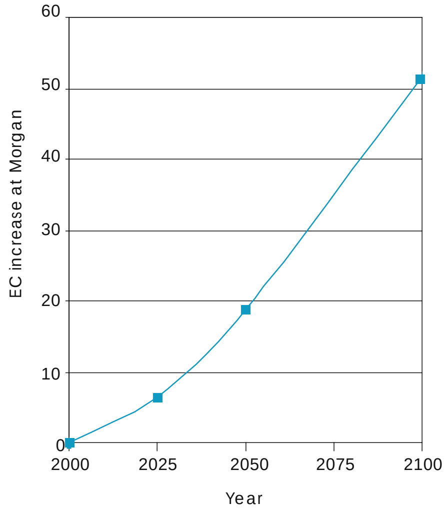
Many NRM regional projects for dryland salinity management involve addressing the imbalance of water in the landscape. The management challenges include:

- Reducing recharge to groundwater systems, usually with deep rooted perennial vegetation; and/or,
- Making productive use of the discharge area, usually with salt-tolerant pasture plants; and/or
- Engineering solutions to intercept and dispose of the saline water.

The NRM Act provides a vehicle for the implementation of Commonwealth funding programs. Since the *2003 SOE Report*, the major sources of funding supporting dryland salinity management have been the Natural Heritage Trust (NHT), National Action Plan for Salinity and Water Quality (NAP) and the National Landcare Program (NLP). On 1 July 2008, these programs were replaced by *"Caring for our Country"* which seeks to integrate the established funding models.

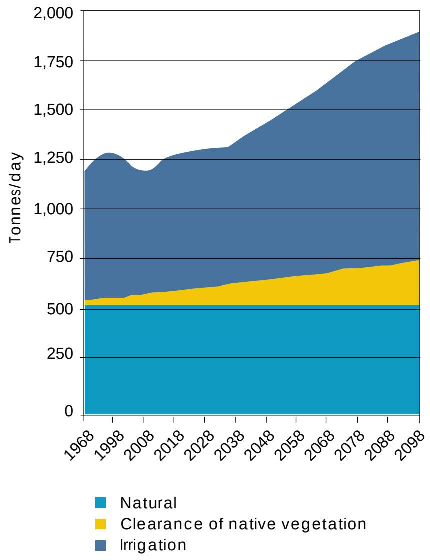
The Upper South East is the largest area affected by and at risk of dryland salinity in South Australia. The USE Program was developed in the early 1990s to address community concerns about dryland salinity, waterlogging and ecosystem fragmentation and degradation. Measures adopted to address these concerns include drainage, saltland agronomy, revegetation and wetland management. The program is close to completion and will continue to provide agronomic, hydrological and biological programs in the region. Its key achievements are outlined in the Critical Program section of this report or for more information visit **www.dwlbc.sa.gov.au/land/programs/use/index.html**

Figure 4.11:Predicted increase in salinity in the River Murray (2000 – 2100)



Source: Barnett and Yan, 2006

Figure 4.12: Salt load to River Murray in South Australia



Source: MDBC Salinity Registers data. Version 21/12/2007

In areas where profitable land use options based on perennial plants exist, large-scale on-ground change has been achieved. For example, in the Coorong District at the lower reaches of the South Australian Murray Darling Basin, salinity was recognised as a major problem in the early 1990s.

In consultation with local landholders a *Local Action Plan* (LAP) was developed, including the target of achieving a 20% reduction in recharge by 2003. On-ground action to control the problem began in 1997 with funds from the NHT and subsequently the NAP. By 2003, the LAP Committee had established or protected approximately 100,000 Ha of perennial vegetation to control dryland salinity, achieving the recharge reduction target set in the LAP (see Case Study).

The other NRM Boards maintain a variety of programs targeting the salinity threat. The Northern and Yorke, and Eyre Peninsula NRM Boards, supported by the Department of Water, Land and Biodiversity Conservation (DWLBC), have set up on-ground works programs promoting establishment of perennials, the protection and invigoration of remnant native vegetation and living with salt options such as 'Sustainable Grazing on Saline Land' sites. The Northern and Yorke, and Kangaroo Island NRM Boards are also installing major new piezometer networks for monitoring groundwater. The Kangaroo Island NRM Board supports various programs for reducing recharge to the groundwater systems including clay spreading, establishment of perennials, protection and invigoration of remnant native vegetation together with engineering (drainage) initiatives.

Furthermore, some NRM Regions commissioned the Rural Solutions SA Salinity Team, with support from the DWLBC Soil and Land Program, to develop salinity risk modelling as part of the Regional NRM development process. Various models highlighted the land and biodiversity assets in regions at the greatest risk of salinity in the event of rising watertables.

In many of the broadscale agricultural areas of the state, such as the Murray Mallee, Eyre Peninsula and Northern and Yorke Peninsula, practical and profitable options for recharge management need to be developed. The state government entered into partnership with the CRC for plant-based management of dryland salinity from 2001-2007. Many CRC research programs have made significant progress into developing new land use systems for profitable use of saline and waterlogged land. The research has continued to investigate opportunities to develop commercially viable farming and forestry systems that will reduce recharge. For example, a key project is FloraSearch, which has made considerable progress in identifying and selecting superior perennial trees and shrubs that could contribute to alternative land management systems for low to medium rainfall regions. More traditional research is also continuing on the use of commercial crops, such as lucerne, for managing recharge.

Many CRC research programs will continue in the new Future Farm Industries (FFI) CRC, which began operation in July 2007. Through DWLBC and the South Australian Research and Development Institute (SARDI), the state government has entered into a new partnership with the FFI CRC. The important FloraSearch project will continue, linking with other CRC projects to develop profitable options for recharge management at the scale required to address dryland salinity and other natural resource management issues, specifically soil erosion and biodiversity.

The Sustainable Grazing on Saline Land Producer Participatory Research and Development program is another successful joint industry and government partnership that completed research in 2007 on profitable and sustainable uses of land affected by dryland salinity. As a result of this and other initiatives in the Upper South East, more than 80% of the affected area has had salt tolerant pasture established, and perennial pastures such as lucerne, have been established on approximately 30% of the agricultural land.

The Coorong District Council

The Coorong District Council covers 8,835 square kilometres in South Australia's Upper South East and Lower Murraylands (geographically, the state's largest Council) The major threats to the district's natural resource management (NRM) include dryland salinity, declines in native vegetation, wetlands and groundwater quality and quantity, wind and water erosion and unsustainable agricultural practices.

The council's Local Action Plan (LAP) Committee was formed in 1995 to produce a plan that addressimg the district's NRM issues with an initial focus on dryland salinity. The plan was released in 1997 and as a result, more than 120,000 Ha of on-ground works have been carried out over 11 years, with funding assistance from the Commonwealth government's Natural Heritage Trust and National Action Plan for Salinity and Water Quality.

The community has embraced the Council's LAP with more than two thirds of landholders actively participating in projects aimed at reducing groundwater levels and improved biodiversity. Projects include revegetation (Photos 1 and 2), perennial pastures (Photo 3), fodder shrubs (Photo 4), farm forestry, saltland pastures, and protection of remnant native vegetation and wetlands. In addition, participation rates from local landholders in the on ground works exceeded 75%. While much of the established perennial vegetation is lucerne, large areas of native vegetation have been fenced and protected from grazing. To sustain this momentum, the LAP Committee runs workshops and fields days and produces factsheets and newsletters to maximise the participation rate and the benefits of on ground.

The Council has been a pioneer in the development of inland aquaculture using saline groundwater, demonstrating the potential of a viable aquaculture industry as well as delivering environmental benefits by alleviating rising water tables

Direct seeded revegetation at Salt Creek 2001.

Same site at Salt Creek after 3 years.

Lucerne at Tintinara to reduce recharge.

Saltbush at Coomandook.

What more should we be doing?

The Environment Protection Authority recommends:

R4.4 Use targeted revegetation to better manage surface water and groundwater, and achieve both economic and biodiversity benefits.

Alignment of Recommendations with South Australia's Strategic Plan targets

	R4.4
Growing Prosperity	
Improving Wellbeing	
Attaining Sustainability	T3.1, T3.2, T3.5, T3.10, T3.11
Fostering Creativity and Innovation	
Building Communities	
Expanding Opportunities	

For further detail on South Australia's *Strategic Plan* visit **www.stateplan.sa.gov.au**

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Further information

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Upper South East Dryland Salinity and Flood Management Program www.dwlbc.sa.gov.au/land/programs/use/index.html

Department of Water, Land and Biodiversity Conservation (Dryland Salinity)www.dwlbc.sa.gov.au/land/dryland/index.html

National Land and Water Resources Audit: Land Salinity www.nlwra.gov.au/Natural_Resource_Topics/Land_Salinity/index.aspx

National Action Plan for Salinity and Water Quality www.napswq.gov.au/

Regional Natural Resources Management Boards www.nrm.sa.gov.au/

The 2nd International Salinity Forum
www.internationalsalinityforum.org/

Future Farm Industries CRC
www.futurefarmcrc.com.au/